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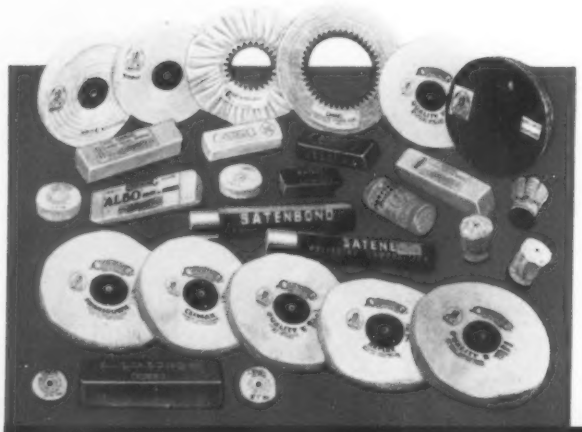


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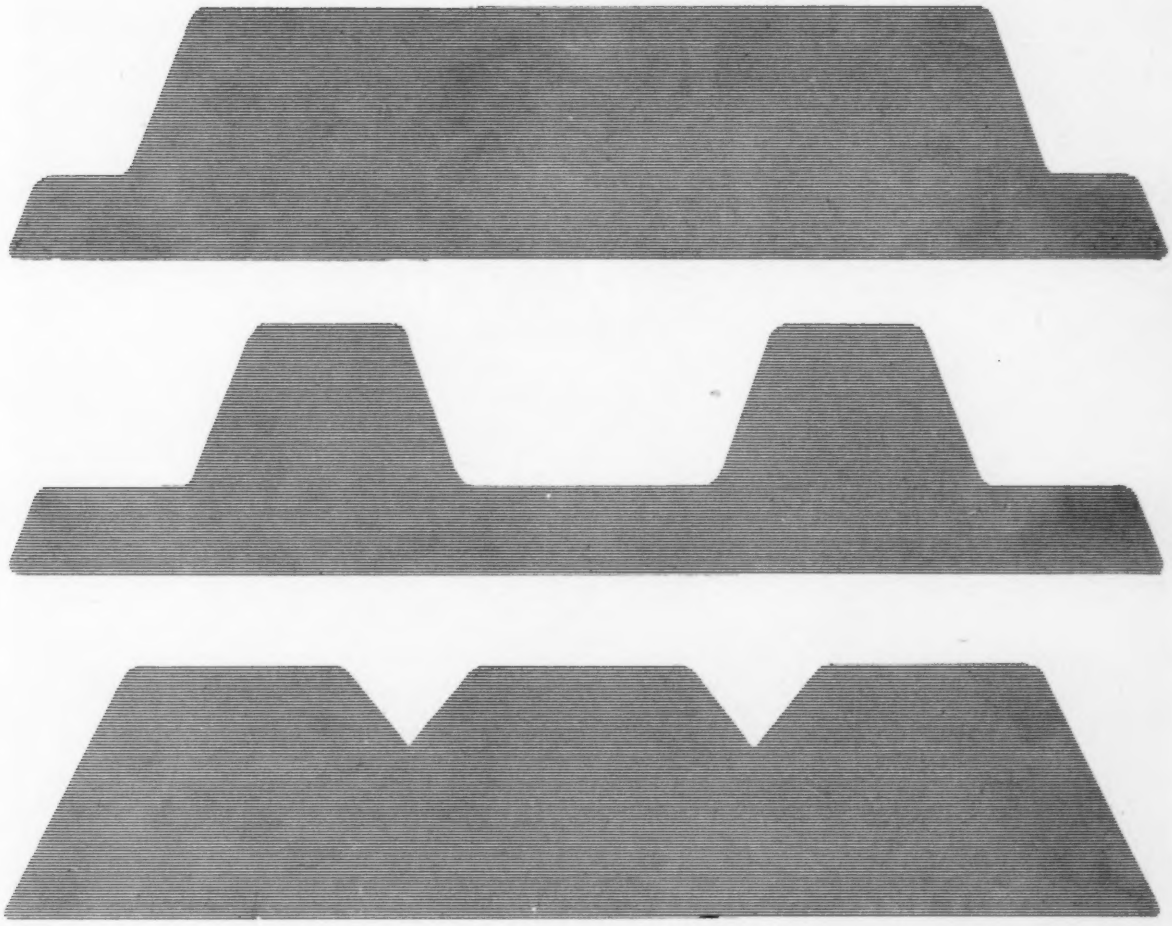

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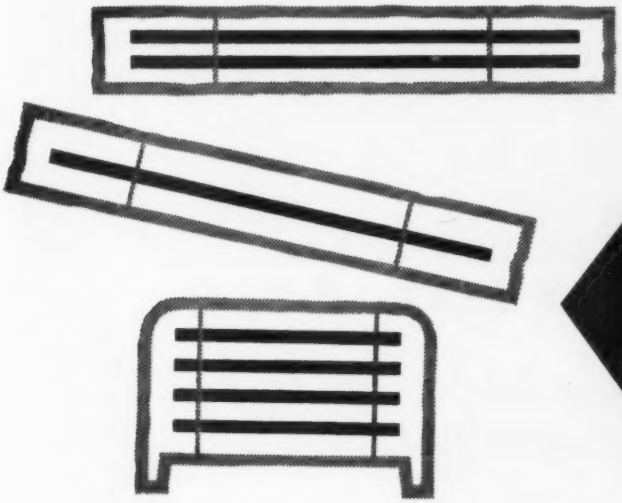

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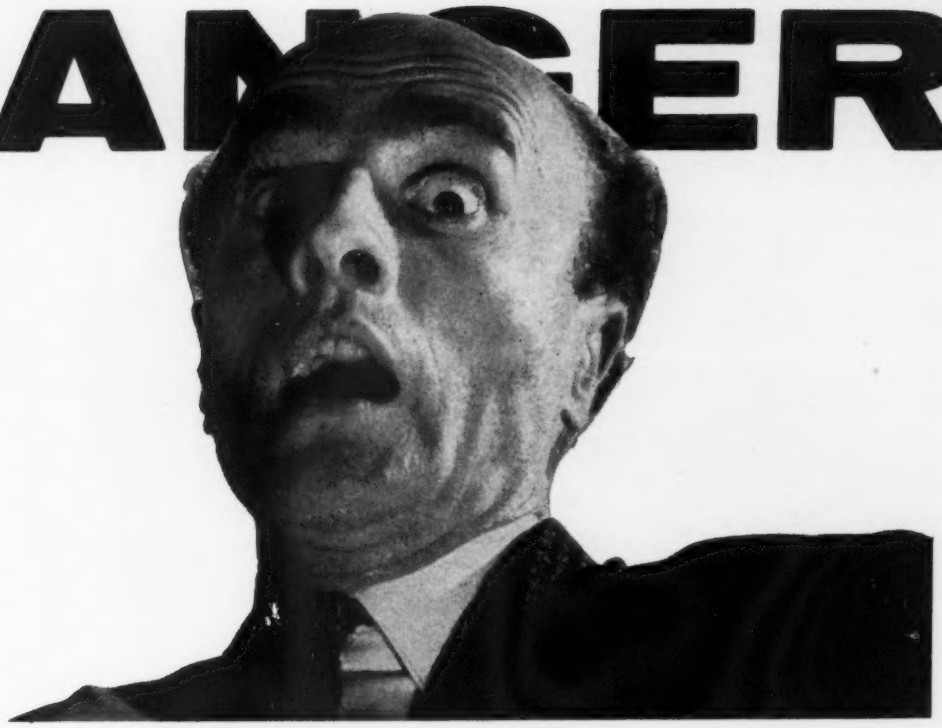

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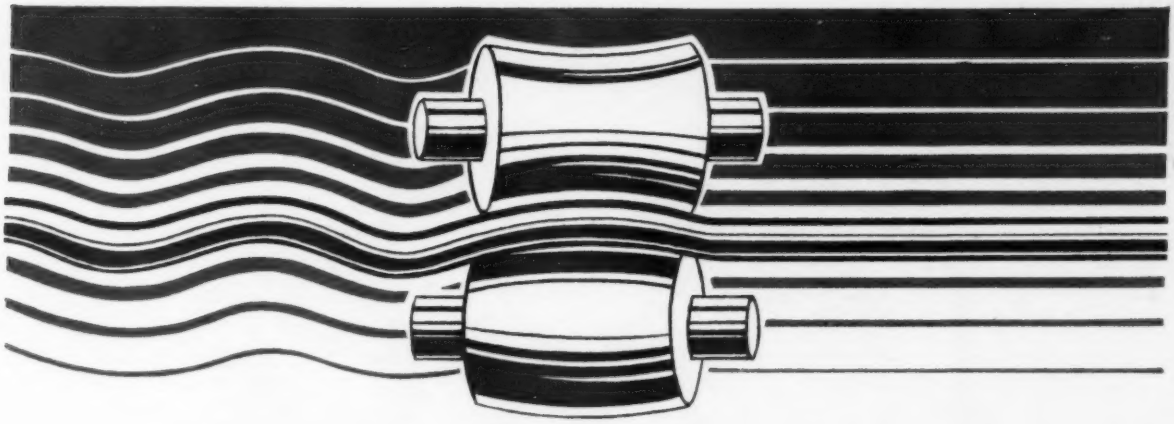

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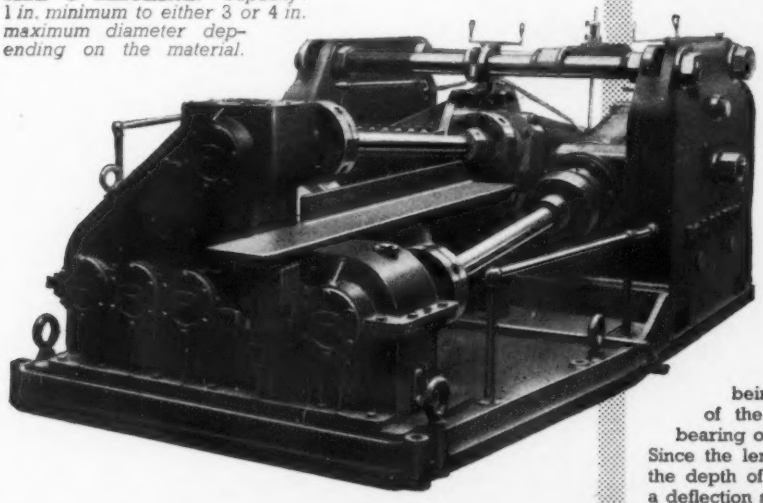

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# Copper Refining

CLAIMED to be the answer to the long-term economic success of copper, a new process of chemically refining and fabricating the metal in an integrated operation is to be carried out at a plant to be built on Mindanao Island in the Philippines, at a cost of approximately £8,000,000. The method, which eliminates smelting, electrolytic refining and casting, is similar to that for the chemical processing of nickel and cobalt ores currently being used successfully in Canada. In the process, copper concentrates are leached with ammonia at a temperature of 85 °C. and a pressure of 20 lb/in$^2$. Copper and zinc pass into solution and the liquid and solids are separated. Copper ammonium sulphate is produced by oxydrolysis, and, from this, copper is precipitated as a powder under temperature and pressure in an autoclave, zinc and ammonium sulphate passing on for further treatment. After drying, the copper powder is compacted between rolls, producing a fragile ribbon or strip which is then subjected to a sintering operation. The sintered strip can then be hot rolled into finished strip or sheet. For tube making, the strip can be formed and welded at high speeds. Wire can be produced in two ways: either by slitting the strip and forming into wire or by melting and casting the metal into billets and drawing in the conventional manner.

The process is said to be an economical proposition for the treatment of many complex copper-lead-zinc-iron ores. Depending on the composition of the ores used, zinc, lead, iron, cobalt, tin and molybdenum are obtained as by-products, as also are ammonium sulphate, a valuable fertilizer, and sulphur. Even allowing for the natural exuberance of the promoters, the apparent major economics of the process are startling. Thus, the cost of processing concentrates to finished strip, which, incidentally, only takes 12 hours, is claimed to be half that of producing electrolytic copper from concentrates and then rolling to strip. Capital costs are also said to be halved. The end product, 99·95 per cent copper, which, incidentally, means that for certain purposes electrolytic refining will still be necessary, is claimed to be superior in quality to copper shapes fabricated by conventional means. Small plants can be run economically; thus, a 50 ton-a-day chemical refining plant is competitive with a 200-ton conventional copper smelter which, at the present time, is generally considered to be the minimum economical unit. The process has the additional advantage that it is suitable for the conversion of even the poorest grades of scrap copper, the type of by-products obtained being, of course, dependent on the composition of the scrap used. It should be pointed out that it is essential for the copper powder obtained to be fabricated directly into mill shapes at the refining plant. The fact that copper powder oxidizes readily would obviously create difficulties in bulk transport if the fabrication plant were located at a distance from the powder plant.

The projected plant in the Philippines will be completely integrated and will process low-grade Philippine ores, of which 75,000 tons a year are currently being sent to Japan for refining and fabrication. It will have a capacity of 14,000 tons a year of semi-fabricated copper, all of which is intended for domestic consumption in the Philippines. In addition, it is expected to produce 5,000 tons of zinc and 100,000 tons of ammonium sulphate annually. The progress of this plant will no doubt be followed with interest by all copper producers.

# *Out of the* MELTING POT

**What Future?** THIRTY years ago, P. H. Carr reported the curious phenomenon of the formation of a "latent image" on the surface of a gold target exposed to electron bombardment. This image could be "developed" by exposing the gold target to hot mercury vapour, when the bombarded area remains unchanged, whereas the surrounding material becomes discoloured by amalgamation. In this way a permanent visual record of the focal spot remains. Recently this phenomenon has been re-investigated as a possible means of obtaining a record of the size and shape of an area which is being bombarded by an electron beam. In some cases, e.g. for weak electron beams, the use for this purpose of the familiar fluorescent screen or photographic methods may be difficult or impracticable. New experimental work has confirmed Carr's observations. It was discovered, however, that developing could be carried out much more conveniently and reliably by plating the bombarded target in an aqueous solution of copper sulphate. On sufficiently strongly bombarded areas no copper was deposited, whereas weaker bombardment resulted in only partial inhibition of deposition. The plating conditions were in no way critical. It was further discovered that latent images were formed by electron bombardment not only of gold targets but of any other metal surface. Once formed, the latent image persists indefinitely, and can be developed at any time after bombardment. The image is not affected by rubbing of the surface with a cloth or by the action of strong acids and alkali. Investigations of the effect of bombardment current, electron energy and bombarding time, as well as of target temperature, showed that the intensity of the image increased to saturation with bombardment time, current and energy, and suggested that the image is formed by a layer of contamination deposited on the originally clean surface of the target. Molecules of organic substances present in the demountable vacuum system deposit on the target, where they are then dissociated by bombarding electrons into free radicles. The latter then form stable chemically inert polymers on the target surface, the formation of these polymers being catalyzed by the surface. Further development, elaboration and, in due course, application of the phenomenon would appear to be a distinct possibility.

**Wrong Tree** VERY often, the excellent advice that time should occasionally be taken to stand back and appraise the work one is doing must remain a counsel of perfection, for the simple reason that no time can be found for the purpose. Certainly, one instance in which no time is available for the appraisal of the task in hand, once it has been started, is that facing those unfortunate people engaged on the subject indexing of current scientific and technical literature. Not only are they liable to find themselves chronically behind schedule but, in the case of a cumulative index, are rapidly building up a powerful "disincentive" to any inclination to pause and reappraise what they are doing and the lines on which they are doing it. To add uncertainty to any doubts that may occasionally pass through the minds of these people, rumours may at times reach them of an investigation being conducted into the efficiency of different systems of subject indexing. What if the conclusions (admittedly still to be reached) of this investigation should show that the particular system they are using is hopelessly inferior to some other system. Would this mean their having to scrap their existing index and re-index everything according to the better system, while still trying, of course, to keep up with current indexing? It is indeed a pity that they cannot eliminate any such anxieties to come by giving some time to an examination that would permit them to realize that there are fundamental reasons which ensure that all systems of indexing, whatever their principle, must be substantially equally complex and time consuming both to the indexer and the users of the index. Moreover, these undesirable characteristics are imposed on indexing systems by the material to which they are applied which, on even superficial examination, can be found to exhibit not the slightest indication of its ever having been intended for being subject indexed.

**Getting There** IN some applications, the poor surface wear and friction characteristics of titanium are a serious drawback or a complete bar to the use of the metal. The matter is complicated by titanium not being exactly an easy metal to plate, deposits suffering in particular from a lack of adhesion which, in some cases, it is true, can be improved by a diffusion heat-treatment (in a vacuum) which strengthens the bond between the deposit and the basis metal. However, such heat-treatment is not always effective. Thus, the adhesion of brass, deposited from a cyanide bath with a view to improving the anti-friction properties of titanium, was not improved by heat-treatment. This necessitated the development of a somewhat roundabout procedure. The titanium surface was prepared for plating by pickling in concentrated hydrochloric acid at 50°C. for 1 hr. After pickling, copper coatings up to 1 mm. thick could be deposited on the titanium from an acid copper sulphate solution. Again, however, the adhesion of these deposits was poor. When attempts were made to improve it by diffusion heat-treatment in vacuum, it was found that coatings thicker than about 30$\mu$ were liable to blister and flake, presumably as a result of the evolution of hydrogen from the basis metal. This snag was avoided by copper plating in two stages: depositing first a coating 15-20$\mu$ thick, which could be heated in a vacuum at 800°C. for 1 hr. to cause diffusion bonding without blistering, and then plating to build up the thickness of the adherent thin coating to 0·5-1 mm. Finally, the copper coating was converted to a brass composition by diffusing zinc into it. This was done by heating the copper-plated part in a mixture of powdered zinc, burnt fireclay, ferro-silicon and ammonium chloride. Six hours at 730-750°C. was sufficient for diffusing zinc almost completely through a 1 mm. thick copper deposit. Wear tests on brass coatings produced on titanium by the above method have given satisfactory results.

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INFLUENCE OF DIFFERENT METHODS FOR MAKING ADDITIONS OF PHOSPHORUS

# Hyper-Eutectic Aluminium-Silicon Casting Alloys

By S. J. ASHTON, M.Eng., A.I.M., J. MUIR, L.I.M. and W. M. DOYLE, Ph.D., M.Eng., F.I.M.

(*Research Division, High Duty Alloys Ltd., Slough*)

HYPER-EUTECTIC aluminium-silicon alloys, particularly those containing approximately 20-25 per cent silicon, have certain very attractive properties, e.g. a high wear resistance and a low coefficient of thermal expansion, which render them particularly suitable for such applications as automobile cylinder blocks, cylinder liners, brake drums and heavy duty bearing caps.

Several British and American automobile manufacturers have recently expressed interest in this type of material, which has been used for a considerable time in Germany for the production of pistons. The advantages of using light alloys in the manufacture of internal combustion engines have been realized for many years, and development work has proceeded with the object of reducing the weight and cost, the ultimate aim being the all-aluminium engine.

In 1933, Koch introduced the eutectic aluminium-12 per cent silicon alloy, which had greatly improved casting characteristics.[1] Although the eutectic alloy pistons showed satisfactory strength at the operating temperatures and a reasonable wear resistance when used in conjunction with chromium-vanadium iron rings and cylinder liners, they had the serious disadvantage of a much higher coefficient of expansion. The pistons had to be designed, therefore, with a loose fit at room temperature, with a consequent increase in wear and loss in power during the first few minutes after starting from cold.

The high wear resistance and the relatively low coefficient of expansion of the hyper-eutectic aluminium-silicon alloys were already known, but it was not until 1938-39 that these alloys were used in Germany for the manufacture of pistons, e.g. KS280, containing 22 per cent silicon. The extent to which the automobile designers' problem of differing coefficients of expansion has been eased may be judged from the figures given in Table I.[2]

Dynamometer and road tests carried out by General Motors[2] with experimental V8 engines have shown that the high silicon alloys possess a satisfactory wear resistance. A comparison[5] of the wear properties of various cylinder materials is presented in Table II.

However, hyper-eutectic aluminium-silicon components will only give a satisfactory performance if they possess a microstructure which contains small, uniformly distributed, primary silicon particles. If this type of alloy is allowed to solidify in the normal manner, at a certain temperature below the liquidus, nuclei of primary silicon are formed by chance arrangement of the atoms in the melt. Once these comparatively few nuclei have formed, the process of crystallization proceeds and the resultant microstructure shows large polyhedral primary silicon crystals with attendant inferior properties. It has been found[4] that the introduction of approximately 0·01 per cent phosphorus to the melt results in the desired formation of comparatively small, rounded primary silicon crystals. The refining action of phosphorus is thought to be due to the formation of particles of aluminium phosphide (AlP), which have the same crystal structure as silicon and so form nuclei around which the primary silicon crystallizes.

It was considered that a systematic investigation was necessary to ascertain the optimum refining procedures for this type of material, and to determine the factors which would affect the production of castings with satisfactory microstructures and mechanical properties. Accordingly, with these objectives in view, the Research Division of High Duty Alloys Limited commenced an extensive series of investigations on hyper-eutectic aluminium-silicon alloys, and the purpose of the present article is to present some of the results obtained.

**TABLE I—EXPANSION COEFFICIENTS OF CYLINDER MATERIALS**

| | Coefficient of Thermal Expansion cm/cm/°C. |
|---|---|
| 'Y' Alloy | $24{\cdot}5 \times 10^{-6}$ |
| Eutectic Al-Si alloys, e.g. LoEx. | $19—20 \times 10^{-6}$ |
| Hyper-eutectic Al-Si alloys, containing up to 20 per cent Si | $18 \times 10^{-6}$ |
| Hyper-eutectic Al-Si alloys, containing 20-25 per cent Si | $16 \times 10^{-6}$ |
| Cast iron (cylinder block) | $12 \times 10^{-6}$ |

**TABLE II—WEAR PROPERTIES OF CYLINDER BORE MATERIALS**

| Bore Material | Duration of Test (hr.) | Average Wear per 100 hr. at Top of Ring Travel (in.) |
|---|---|---|
| Iron plate on 356-T7 alloy (LM8) | 119 | 0·00405 |
| 0·0015 in. chromium plate on 356-T7 alloy (LM8) | 134 | 0·00462 |
| Standard cast iron | 684 | 0·00070 |
| 0·005 in. molybdenum sprayed on 356-T7 alloy (LM8) | 457 | 0·00060 |
| Uncoated 356-T7 alloy (LM8) | 128 | 0·00055 |
| Uncoated high-silicon alloy | 227 | 0·00038 |

## Silicon Phase Refinement

It has been found[5] that for nucleation to occur in liquid aluminium by the normal process of crystallization, the amount of under-cooling required may be as large as 60°C. It has also been shown[5,6] that the presence of certain heterogeneous nuclei in liquid aluminium will lead to the virtual suppression of the under-cooling which normally occurs in a melt. Terai[7] discovered that high silicon melts containing such nuclei, e.g. AlP, could not be under-cooled by more than a few degrees (see Table III).

Heterogeneous nuclei may be either minute particles of insoluble impurities or deliberately added agents. At a certain degree of under-cooling, the crystallizing phase will find it easier to form on the surfaces of suitable nuclei.

It has been shown that if the addition agent has a lattice arrangement and spacing close to that of the nucleating phase, then the degree of under-cooling required to produce nucleation will be small.[8] A comparison of the lattice constants for a number of phases is given in Table IV, from which may be seen that both zinc sulphide (ZnS) and aluminium-phosphide (AlP) have very similar values to silicon and, in fact, both have been investigated[4,7] as methods for refin-

**TABLE III—UNDER-COOLING EFFECT OF SODIUM AND PHOSPHORUS**

| | Addition Element | Rate of Cooling (°C/min.) | | |
|---|---|---|---|---|
| | | 8 | 60 | 120 |
| Degree of under-cooling of liquidus—°C. | No addition | 0 | 3 | 5 |
| " " " " " " " | P | 0 | 0 | 4 |
| " " " " " " " | Na | 2 | 4 | 10 |
| Degree of under-cooling of eutectic—°C. | No addition | 2 | 5 | 12 |
| " " " " " " " | P | 2 | 2 | 4 |
| " " " " " " " | Na | 7 | 15 | 27 |

**TABLE IV—LATTICE CONSTANTS**

| Phase | Lattice Constant |
|---|---|
| AlAs | 5·63 |
| AlP | 5·45 |
| ZnS | 5·45 |
| Si | 5·42 |

ing the primary silicon phase in hyper - eutectic aluminium - silicon alloys, although the addition of phosphorus is the more commonly used.

The surface of the nucleating agent has generally a layer of foreign atoms chemisorbed on it[9] which may affect the lattice spacing, and thus a small amount of alloying element or impurity in the melt may profoundly modify the refining efficiency. Terai[7] has shown that the addition of arsenic, boron and copper slightly assists in the refining of the primary silicon of hyper-eutectic aluminium-silicon alloys; magnesium and sodium hinder; and beryllium, cadmium, cobalt, chromium, iron, manganese, titanium and zinc have no effect in the quantities detailed in Table V.

It is considered, therefore, that if sufficient heterogeneous particles suitable for nucleating the primary silicon phases (e.g. AlP) are present in the melt, and are solid at the liquidus temperature, then a large number of primary silicon crystallites will be produced. The resultant microstructure will contain small primary silicon particles evenly disseminated throughout the eutectic matrix. The eutectic silicon formed under these conditions is coarse, although the nuclei should, theoretically, be capable of effecting refinement. It is thought that the reason for this apparent anomaly is that to bring about refinement of the eutectic silicon, many more nucleating particles would be required than in the case of the primary silicon phase. The eutectic silicon can be refined, however, by producing under-cooling by means of severe chilling.

## Optimum Addition Method

As particles of aluminium-phosphide appear to be very effective in nucleating hyper-eutectic aluminium melts, it was decided to investigate several possible methods of adding phosphorus and to determine the amounts necessary to produce the required degree of refinement of the primary silicon particles (0·06 mm. maximum).

It was considered advisable, in the first instance, to concentrate on the addition of phosphorus by means of solid compounds, since gaseous decomposition phases, such as phosphorus pentachloride, would involve the use of relatively complicated techniques. Further, copper-phosphorus hardeners were not explored, as it was thought that the usefulness of this method would be limited to those compositions in which copper was a definite alloying addition. Three proprietary compounds were selected for examination, namely, "EP1136" and "Nucleant 10", both of which were supplied by Manufacturer A, and self-sinking ferro-phosphorus alloy tablets supplied by Manufacturer B.

The EP1136 contains red phosphorus and an additional grain refining agent. This preparation is sodium-free as this element is known to have an adverse effect on the efficacy of refinement with phosphorus, and is supplied in aluminium canisters which are plunged to the bottom of the melt. The addition recommended by the suppliers is 5 oz. per 100 lb. of melt, i.e. approx. 0·06 per cent phosphorus.

Nucleant 10 is based on a mixture of red phosphorus and hexachlorethane and is supplied in tablet form. It is recommended that it should be added by plunging in the ratio of 4 oz. per 100 lb. metal (approximately 0·06 per cent phosphorus).

The ferro-phosphorus tablets are self-sinking and are manufactured by compacting a mixture of flux and a compound, in powder form, containing iron and phosphorus in the ratio 4 : 1. The compacts are then sealed in aluminium containers. High Duty Alloys Limited Research Division specified that the flux should be sodium-free and that the ferro-phosphorus powder should be of the order of 200 mesh. This particle size was recommended for it has been shown[4] that the grain size of the phosphorous-containing agent exerts a marked effect on the final crystal size of the primary silicon.

In order to assess the effectiveness of the various additions, the following test castings were produced from each melt; a die-casting with a $\frac{1}{2}$ in. diameter stem in the centre of a disc, 2 in. diameter by $\frac{1}{8}$ in. thick; a 1 in. diameter die-cast bar, and a standard 1 in. diameter DTD sand-cast bar.

Although these section thicknesses are representative of the majority of production aluminium alloy castings, it must be appreciated that the heat content of larger castings and the use of hot dies or sand moulds will considerably reduce the rate of cooling. Throughout the series of experiments described, all the dies were maintained at a temperature of approximately 150° C.

## Casting Details

Thirty-pound virgin melts in the hyper-eutectic aluminium-silicon alloy containing (per cent) 23·5 silicon, 1·0 copper, 1·0 magnesium, 0·9 nickel, 0·5 chromium (H.D.A. designation: EX.451) were processed by the following technique :—

The charges, with the exception of the magnesium, were melted and heated to 800° C. to dissolve the silicon hardener alloy and then cooled to 740° C. for the introduction of the magnesium. The various phosphorus additions (see Table VI) were made after raising the temperature to 800° C., following which the melts were degassed at 780°-800° C. with 4 oz. of Degasser 450 tablets, using a hooked degassing rod. Coveral 65 (sodium-free) was used as a cover throughout, and finally the charges were poured at 800° C. into three die-cast discs and six die- and six sand-cast test bars.

It was observed that as the amount of EP1136 added was raised above the recommended addition, the extent of flaring and burning increased. This could be controlled to some extent by increasing the flux cover, but this procedure is not considered advisable as

**TABLE V—EFFECT OF THE SOLUTE ELEMENT ADDED WITH PHOSPHORUS ON THE SIZE OF THE PRIMARY SILICON PARTICLES**

| Solute Element | None | As | B | Be | Cd | Co | Cr |
|---|---|---|---|---|---|---|---|
| Weight percentage added | | 0·005-0·05 | 0·005-0·05 | 0·005-0·05 | 0·10-2·5 | 0·10-2·5 | 0·10-1·00 |
| Size of primary silicon in mm. | 0·02 | 0·02-0·01 | 0·02-0·01 | 0·02 | 0·02 | 0·02 | 0·02 |
| **Solute Element** | **Cu** | **Fe** | **Mn** | **Mg** | **Na** | **Ti** | **Zn** |
| Weight percentage added | 0·10-4·50 | 0·10-1·00 | 0·10-1·00 | 0·10-2·00 | 0·005-1·00 | 0·01-0·15 | 0·10-2·10 |
| Size of primary silicon in mm. | 0·02-0·01 | 0·02 | 0·02 | 0·02-0·08 | 0·02-0·06 | 0·02 | 0·02 |

**TABLE VI—PHOSPHORUS CONTENTS OF TEST CASTINGS**

| Nominal percentage Phosphorus added to the Melt | Percentage Phosphorus Content | | |
|---|---|---|---|
| | "Soluble" | "Insoluble" | Total |
| *Refined with EP*1136 | | | |
| 0·015 | 0·0020 | 0·0069 | 0·0089 |
| 0·030 | 0·0018 | 0·0081 | 0·0099 |
| 0·06 | 0·0020 | 0·0111 | 0·0131 |
| 0·12 | 0·0036 | 0·0125 | 0·0161 |
| 0·24 | 0·0050 | 0·0123 | 0·0173 |
| *Refined with Nucleant* 10 | | | |
| 0·015 | 0·0011 | 0·0042 | 0·0053 |
| 0·030 | 0·0014 | 0·0091 | 0·0105 |
| 0·060 | 0·0040 | 0·0106 | 0·0146 |
| 0·12 | 0·0127 | 0·0168 | 0·0295 |
| 0·24 | 0·0384 | 0·0234 | 0·0618 |
| *Refined with Ferro-phosphorus* | | | |
| 0·005 | 0·0031 | 0·0052 | 0·0083 |
| 0·01 | 0·0032 | 0·0092 | 0·0124 |
| 0·05 | 0·0182 | 0·0119 | 0·0301 |
| 0·10 | 0·0814 | 0·0201 | 0·1015 |

concurrent work has shown that it may lead to an increased gas content. This latter investigation is discussed in the section dealing with degassing. The reaction following the addition of Nucleant 10 to the melt was far more vigorous and only one 2 oz. tablet could be plunged safely, without splashing, at any one time. The ferro-phosphorus tablets were very simple to use and produced no objectionable fuming or burning.

### Chemical Composition

The total phosphorus contents of representative die-castings from all the melts were determined, and are shown in Table VI. The "soluble" phosphorus figures given in this Table represent the phosphorus released as phosphine by the action of hydrochloric acid on the alloy. The "insoluble" results represent the fractions fixed in the acid-insoluble silicon residue. The "insoluble" phosphorus content, therefore, is the more interesting for it is that which is associated with silicon, and is presumably responsible for the nucleation and refinement of the primary silicon. However, the accuracy of the "insoluble" values given by these analytical methods has not yet been proved conclusively. It is thought that slight errors might occur due to the possibility of some "insoluble" phosphorus being leached out during the attack with hydrochloric acid and that, in addition, these figures might include phosphorus in other combined forms, not associated with the silicon, but which are also not dissolved by this acid. However, it is considered that although the values given by this method of analysis for "insoluble" phosphorus may not be intrinsically correct, any conclusions made regarding trends shown by this part of the total content will be valid.

With additions of 0·015-0·06 per cent phosphorus, using EP1136, the "insoluble" phosphorus level increased and then remained constant at about 0·012 per cent. However, there was a progressive, though not linear, rise in total phosphorus content with the additions, but the loss was of a high order, particularly in the cases of the higher percentages. Similarly, the total phosphorus contents increased with the amount of Nucleant 10 added, but substantially higher contents were obtained with additions greater than 0·03 per cent phosphorus. Further, the "insoluble" phosphorus increased progressively to 0·0234 per cent with the Nucleant 10 additions. It must be pointed out here that the manufacturers of the ferro-phosphorus tablets, in order to be able to guarantee a certain minimum content in the final castings, add a slight excess of phosphorus to compensate for the melting loss.

This explains the apparent anomalies in Table VI in which the total phosphorus contents are sometimes higher than the "nominal" amounts added to the melts. It may be seen from this Table that the "insoluble", "soluble" and total fractions all increased with the amount of ferro-phosphorus added, and that the recovery is of a much higher order than with the other two nucleants.

The iron content of the castings from the melts treated with ferro-phosphorus did not show a significant increase until more than 0·050 per cent phosphorus had been added to the melt, as may be appreciated from the following percentages:—

| Nominal phosphorus addition | 0·005 | 0·01 | 0·05 | 0·10 |
|---|---|---|---|---|
| Iron content .. | 0·20 | 0·24 | 0·38 | 0·60 |

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*(To be continued)*

# Standard Specification

*Wrought High Tensile Brass Rods and Sections (other than Forging Stock) and High Tensile Brass Forging Stock and Forgings (B.S.250 and B.S.1001). Price 5s.*

IN preparing British Standard schedules for wrought copper and copper alloys (B.S.2871 - 2875) an attempt has been made to rationalize the specifications for high tensile brass and in line with this, B.S.250 and B.S.1001 have been revised.

High tensile properties of rods are obtained either by alloying, or up to a certain size by cold working, or by a combination of both, and materials of these types have traditionally been supplied. The 1940 edition of B.S.250 was drafted to permit the use of a number of alloys containing up to 7 per cent of alloying elements which would give the desired properties. The revised edition includes two compositions, both of which are identical with alloys being included in the series of schedules for wrought copper and copper alloys, and the designations used are identical with those in the schedules. CZ.114 is a general purpose alloy which is more closely defined than that specified in the earlier edition of the standard and will meet most engineering requirements. CZ.122 has superior machining properties, is of the same composition as that specified in B.S.218 "Brass Bars and Section (Suitable for Forgings) and Drop Forgings", and the required mechanical properties are obtainable by cold work. Except for CZ.114 in sizes 3 - 6 in., the high mechanical properties are lost if the materials are heated and they are, therefore, not suitable for forging.

The new edition of B.S.1001 specifies a medium strength alloy designated CZ.115, which is specially suitable for use where the material has to be soldered. This alloy, together with CZ.114 and a third high tensile brass CZ.116, is also included in the schedule of forging stock and forgings (B.S.2872, "Copper and Copper Alloys: Forging Stock and Forgings"), which will shortly be published. B.S.1002 has been withdrawn.

The same three high tensile brasses are also included, with appropriate mechanical properties, in the schedule of rods and sections (B.S.2874, "Copper and Copper Alloys: Rods and Sections, other than Forging Stock"), which will also be published soon.

Copies of the above - mentioned standard may be obtained from the British Standards Institution, 2 Park Street, London, W.1.

# Men and Metals

An announcement from the Institute of Metals states that the Council of the Institute has awarded the Institute's Platinum Medal for 1961 to **Major C. J. P. Ball,** chairman of Magnesium Elektron Limited, in recognition of his "outstanding services to the non-ferrous metal industries and, in particular, to the magnesium industry".

The Rosenhain Medal of the Institute of Metals has been awarded to **Dr. P. B. Hirsch,** of the Cavendish Laboratory, Cambridge. The award was made for his "outstanding contributions in the fields of physical metallurgy and metal physics".

It has been announced that **Mr. K. R. Simmonds,** B.Sc., A.M.I.E.E., has been appointed managing director of International Rectifier Company (Great Britain) Limited, a company owned jointly by Metal Industries Limited and the International Rectifier Corporation of Los Angeles. Mr. Simmonds joined the company in 1959 as general manager.

Elected to honorary membership in the American Institute of Mining, Metallurgical and Petroleum Engineers is **Dr. John F. Thompson,** honorary chairman of the International Nickel Company of Canada Limited, and of its United States subsidiary, the International Nickel Company Inc.

The Council of the recently formed Drop Forging Research Association has appointed **Mr. P. H. R. Lane,** B.Sc., A.I.M., to be the first director of research to the association. For the past twelve years he has been with the British Welding Research Association, where he was head of the members' service department.

In succession to Mr. P. H. R. Lane (mentioned in the above paragraph), **Mr. R. P. Newman,** A.M.I.Mech.E., has been appointed head of the members' service department of the British Welding Research Association. **Mr. T. R. Gurney,** M.A., A.M.I.C.E., will succeed Mr. Newman in charge of fatigue researches at the association.

Formerly works engineer to Chamberlain Industries Ltd., **Mr. Dennis W. Gray,** A.M.I.Mech.E., has been appointed works director, and **Mr. Richard R. Watkins,** M.S.M.A., who joined the company as general sales manager, has been appointed sales director.

Four new directors have been appointed to the board of Fletcher Miller Limited, a member of the Castrol group of companies. They are **Mr. J. R. Bickerton,** chief chemist at the Hyde, Cheshire, plant; **Mr. J. Birchenough,** works manager at Hyde; **Mr. R. A. Miller,** North London divisional sales manager; and **Mr. S. V. Tilley,** senior technical representative for the Midlands and South Wales.

It has been announced by Ferodo Limited that they have appointed **Mr. B. G. Hill** as their export sales manager. He joined the company in 1953 as a graduate trainee from St. John's College, Oxford.

Chairman of Stein and Atkinson Limited for the last ten years, **Mr. Russell Smith** has now retired. He is succeeded as chairman by **Mr. H. W. Howes,** who has been a director of the company for the past 11 years.

On the occasion of his retirement as chairman of the Cementation group of companies, **Mr. A. R. Neelands** has been invited to become President of the group, a position he has accepted. **Sir F. A. Pile** has been elected chairman of the group.

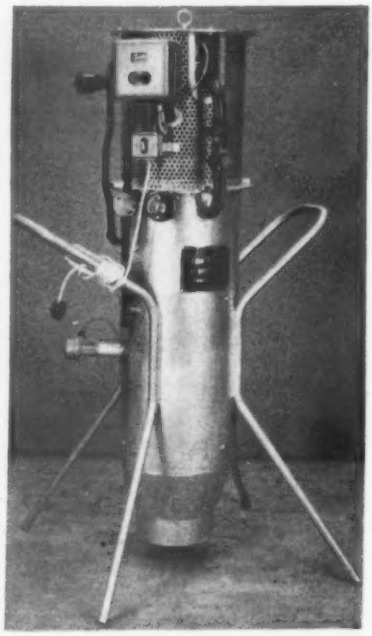
In succession to **Mr. P. Jardine,** it is understood that **Mr. E. F. Coppock** has been appointed to the position of group financial controller to Metal Industries Limited.

# Drying Moulds

A PROTOTYPE portable gas-fired air drier, specifically designed for the floor drying of foundry moulds, was developed recently by the North Western Gas Board, and is now being manufactured by Modern Furnaces and Stoves Ltd., of Booth Street, Handsworth, Birmingham. Among its advantages is the fact that it stands vertically and takes up a minimum of floor space. In one installation, 15 cwt. moulds were dried *in situ* in 9½ hr. where previously 16 hr. were required when drying was done in an oven.

The dryer is of mild steel construction, fitted with tubular legs and looped handles. The outer casing ends in a conical nozzle to give increased velocity to the outgoing gases. A lifting eye-bolt is fitted on top of the casing above the control chamber for facilitating crane handling.

*Portable gas-fired mould dryer designed by North Western Gas Board and manufactured by Modern Furnaces and Stoves Ltd.*



Controls include a solenoid valve to cut off the gas supply in case of electrical failure and to operate in conjunction with electronic flame failure equipment. Spark ignition is arranged to operate immediately the unit is switched on and to remain on until the flame is established; this also works in conjunction with the flame failure equipment.

A natural draught gas burner is fitted inside the casing and is arranged to burn in a heat-resisting steel combustion chamber, placed concentrically inside the casing and allowing an annular space between the two cylinders for the passage of air to be heated.

The blower is a flange-mounted axial type fan, of ample capacity, and is fitted with a totally enclosed fan-cooled motor, on the rotor shaft of which the fan impellor is fitted. In operation, the fan provides the medium for keeping the outer casing cool, while at the same time projecting a jet of high velocity hot air through the outlet nozzle at the bottom of the unit.

The dryer stands on four legs formed integrally with the handles and welded to the outer casing.

The total weight of the hot air unit is approximately 140 lb. Gas consumption is approximately 850 $ft^3$/hr. of town's gas, and the dryer is designed to deliver 500 $ft^3$/min. of hot air at temperatures up to 400°C.

Thermostatic control is by an automatic preset type thermostat operating a solenoid valve in the gas line.

A flame failure control is incorporated comprising a probe of special heat-resisting alloy positioned to enter the combustion chamber, and an electronic manual reset unit to cut off gas supply in case of flame failure. The control only allows resetting after a purging period of 20 sec.

**Finishing Supplement**

# Cleaning of Surfaces

By E. E. BISHOP

MANY of the problems in metal finishing can be associated with inefficient cleaning. All methods of a preparational nature should produce clean, active and coherently strong surfaces. Unfortunately, few cleaning cycles provide these requirements, and their inability to do so results in the article prematurely failing in service which, in the event of there being numerous complaints, reflects adversely on the industry.

The material to be removed from a surface may be composed of either organic or inorganic compositions in combination with metal swarf from machining operations, or abrasives from grinding and polishing. This may be further complicated by the presence of heat-treatment scale or a natural oxide formation as in the case of aluminium. The relationship between these conditions is illustrated diagrammatically in Fig. 1, which indicates the relative position of scale and grease on a typical dirty metal object. It will be seen that the article is surrounded by a closely adhering layer of scale which is itself covered in grease. For the cleaning sequence to be completely effective, it is first necessary to remove the grease, when it is then possible to dispense with the scale.

The degree of surface cleanliness required from a cleaning sequence will, to a large extent, be controlled by subsequent finishing treatments. If, on the one hand, the article is to be electroplated, a high standard of surface cleanliness is essential, whilst it may not be necessary to obtain the same conditions for acid pickling in the case of components having on their surface heat-treatment or forging scale. Due consideration, therefore, must be given to a number of factors before recommending a suitable sequence.

In order to lay down a specification to cover a suitable cleaning sequence, it is first necessary to determine the degree of surface cleanliness required from this operation. The controlling factor will, in the main, be dictated by subsequent steps in the manufacturing cycle since the cleaning step may be required as an inter-stage operation only, in which case the degree of cleanliness need not be so thorough as would be necessary if preceding an electroplating process.

Care must be exercised to ensure that the process does not induce hydrogen embrittlement into the object being treated, since this may have an adverse effect on the service life of the article, resulting in premature failure. Fortunately, sufficient is known about this effect to enable it to be rectified in the majority of cases. It is always safer, for example, to insist on a stress-relieving operation in the case of steel having a tensile strength in excess of 45 ton/in$^2$, this operation, of necessity, being applied after application of the final finish.

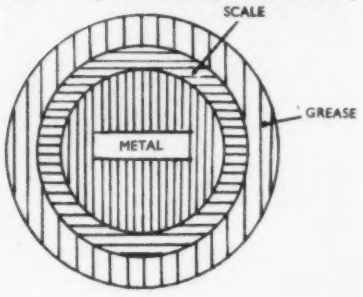
Attack on the basis metal may occur in one of two forms. First, as a general attack on the surface and, secondly as a preferential attack of one or more of the constituents. In the first instance, the condition is not normally detrimental if the article is to be electroplated, in fact most sequences which lead up to an electroplating process have as an integral part one step which attacks the basis metal to assist in adhesion of the deposit. On the other hand, a similar step in a phosphating line has an adverse effect on the quality of the chemical conversion coating, resulting in a coarsening of the crystal size, necessitating rubbing down where an organic coating is to be applied.

In the majority of cases, a cleaning step is considered to be an evil necessity and, as such, little attention is given to its location. The cleaning sequence must, therefore, be adequate to fulfil the role for which it is required, and, as such, it is essential that the maximum utilization of space be made with the minimum number of steps in order to accommodate the most comprehensive cleaning system in the space allocated.

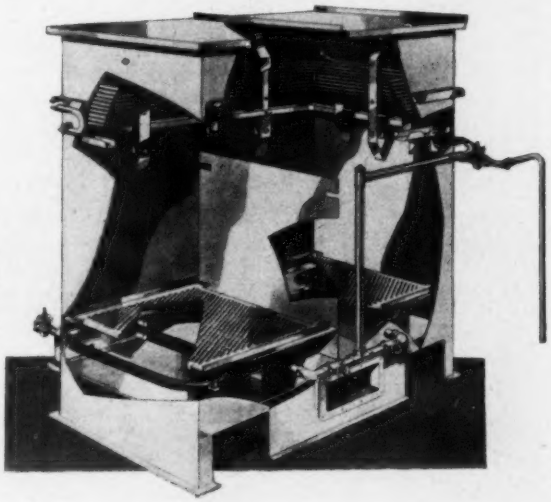
## Choice of System

The choice of cleaning systems varies according to the class of basis metal to be cleaned. It is not general practice in large installations, other than where solvent cleaning is used, to accommodate both ferrous and non-ferrous metals in the same system. Wide selections of both acid and alkali cleaning formulations are available for the treatment of ferrous metals. However, the range is limited in the case of non-ferrous metals to the weaker acid and alkali compositions.

Economically speaking, the cleaning operation will be dependent on the cost of the materials, time, labour and consumption of electric current where used. Due to the comparatively large volume of work which can be accommodated in an alkaline cleaner, for instance, before it is considered spent, the cost of chemicals is but a small fraction of the total cost. The time factor will mainly be controlled by the overall cycle time, the size of plant being dictated by the volume of production required. The labour charge accounts for the major cost. In consequence, therefore, the efficiency of the cleaning cycle will, to a large extent, be controlled by a good layout, eliminating operator fatigue with the




*Left: Fig. 1—Conventional diagram illustrating relationship between metal, scale and grease on a metal article before cleaning (after Simonds)*



*Right: Fig. 2—Cut-away illustration of the LV3 liquor vapour degreasing plant*

*[Courtesy Imperial Chemical Industries Ltd.*

maximum utilization of automatic devices where cost permits.

The ideal cleaning sequence should, therefore, satisfactorily accommodate each of the foregoing factors. This, however, is not always possible, mainly due to limitations of space or on economic grounds. The choice of sequence must, therefore, rest upon a thorough knowledge of the type of grease to be removed, these generally falling into three classes. First, those of a non-saponifiable or mineral oil nature; secondly, the saponifiable or vegetable based variety; and finally, combinations of both classes. It has been found by experience that, in order to safeguard subsequent processing solutions, the most sensible approach is to consider a cleaning cycle which will accommodate both classes of material, and in order to do this the metal finisher has many techniques from which to choose. The five principal methods available by which metal surfaces can be cleaned are mechanical processes, solvent, alkali, acid, and ultrasonic cleaning. Depending on surface conditions, each of these may be used separately or in conjunction with one another to produce a desired degree of surface cleanliness, depending upon the ultimate finish requirements.

Contamination of metallic surfaces may be treated by various techniques, depending upon the type and quantity of material involved. Large engineering structures, however, necessitate a different approach to that of small articles which are to be protected by electroplating or by a chemical conversion coating, although the object of the exercise in both cases is surface cleanliness. In the first instance, the structure can only be treated by mechanical methods, whilst the small component may be treated by any of the systems mentioned above.

## Solvent Degreasing

In providing for efficient and rapid removal of oils, greases and waxes, advantage is taken of the benefits to be obtained from solvent degreasing. The chlorinated hydrocarbons, of which trichloroethylene is the most popular, have found favour due to the high affinity of these solvents for the majority of greases encountered in metal finishing, and such degreasing plants are often found as the central feature of the process in most engineering factories.

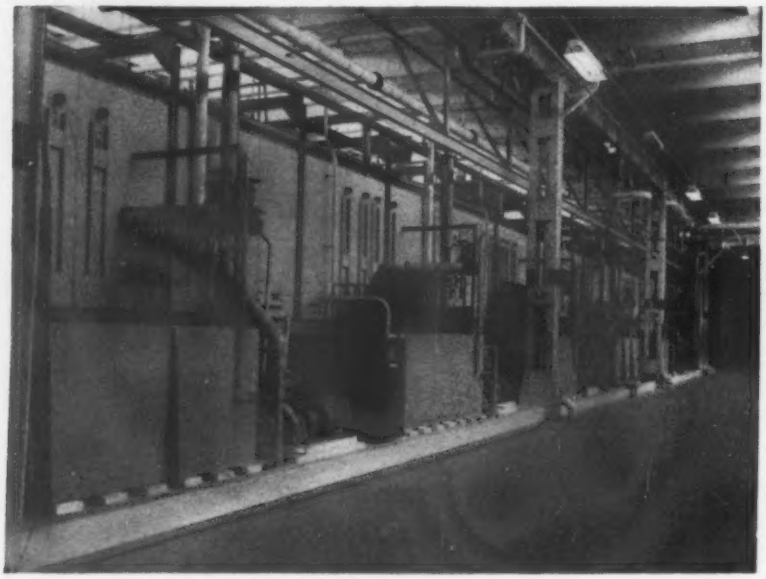
The stabilized trichloroethylene supplied for use in degreasing plants today is quite safe if used in equipment designed to accommodate it and, because of its low specific heat, comparatively high vapour weight and ease with which it lends itself to stabilization, is used extensively in this country. Perchloroethylene, however, is preferred in certain countries, particularly where there are large amounts of moisture present and the operation combines both degreasing and drying of the article. These solvents, under normal operating conditions, will not attack steel or light metals. They will, however, if overheated, break down with the formation of free hydrochloric acid, resulting in attack on the metal being degreased, in particular the light metals. This condition is accentuated by the presence of light metals in a finely divided form within the degreasing plant. It was common practice some years ago to place lime or soda ash in the bottom of the tank in order to assist in maintaining the solvent in a "sweet" condition. However, with the increased stabilization of trichloroethylene today, this is no longer necessary. Nevertheless, the alkalinity of the solvent should be tested from time to time to minimize the possibility of decomposition caused by the presence of metals such as aluminium, magnesium and the zinc-base alloys. Regular weekly cleaning out of the plant engaged on the degreasing of such metals is essential to prevent trouble due to this condition.

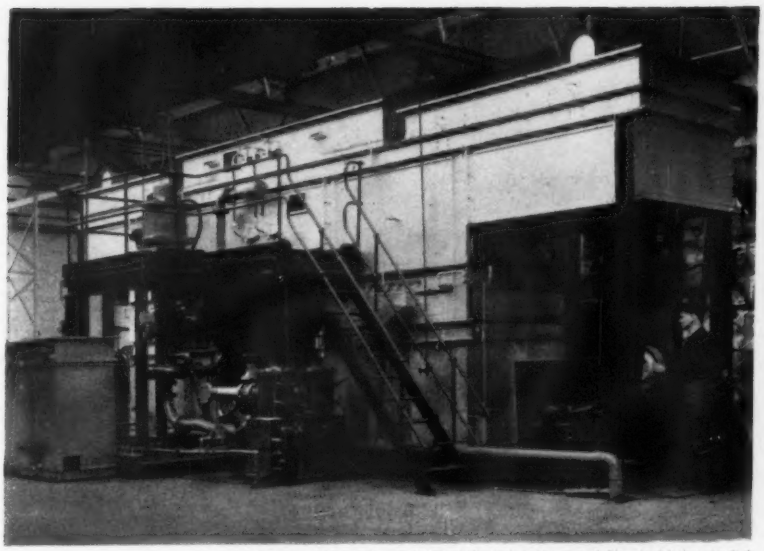
There are three main types of trichloroethylene degreasing plants available to the metal finisher, and it is important that the advantages and limitations of this equipment be understood. The vapour plant consists essentially of a galvanized tank having a bank of copper condensing coils running along the top inner wall of the tank, preventing escape of solvent vapour into the atmosphere, the trichloroethylene being contained in the base of the container, which is heated by either gas, steam or electricity. The vapour degreaser functions by the condensation of clean solvent on the cold metal component, this dissolving oil and greases and running into the sump, condensation continuing until the article has reached the temperature of the vapour, when no further degreasing takes place.

Liquor vapour degreasing plants have been designed to accommodate both boiling trichloroethylene and its vapour. The advantage in the use of this type of equipment is that it will accommodate thin gauge components, on which the rate of condensation decreases rapidly due to the thickness of material, permitting the object to reach the temperature of the solvent vapour before all the oil and greases have been removed. It is general practice to make use first of the liquor,

*Below: Fig. 4—Large Bonderizing plant recently installed at Ford Motor Co. Ltd. works at Dagenham* [Courtesy Pyrene Co. Ltd.

*Right: Fig. 5—Car wing passing through Spra-Bonderizing plant*





[Courtesy Dunlop Rim and Wheel Co. Ltd. and Imperial Chemical Industries Ltd.

*Fig. 3—Continuous high-pressure jetting and vapour degreasing plant*

in cases where the article has on its surface abrasive and metal swarf. The boiling solvent, having a scrubbing action, assists in its removal. In applications where the article is covered only in grease and oil, the vapour compartment is used first, followed by rinsing in the boiling liquor.

In the case of grease and dirt being removed faster than the rate of self-cleaning in one liquor compartment, it may be necessary to have a multi-stage plant having two or more boiling liquor stages arranged in line through which the condensate flows in cascade, into the vapour compartment, this again functioning as a still, concentrating the greases and oils and releasing the vapour for self-cleaning purposes.

Trichloroethylene is a comparatively expensive solvent, and considerable quantities are used in degreasing operations. In view of this, the material must be used economically, and much can be done by the user to ensure maximum utilization of the solvent. Initially, regular maintenance schedules must be laid down to keep burners and thermostats adjusted correctly and to provide a sufficient flow of cooling water in the condensation coils. However, since the solvent is lost in both drying off the article and by displacement when loading or unloading, materials can be saved in manually operated plants by having a slow acting hoist removing work at the rate of approximately 10 ft/sec., until it is clear of the tank. In conveyorized installations, a speed of 4 ft/sec. can be used. Further economies can be made when degreasing hollow or deeply recessed articles by placing them in a basket so that they do not trap solvent. In the event of this arrangement not being possible, a circular wire cage can be designed which, when rotated either mechanically or manually within the plant, removes the entrapped solvent.

## Alkali Cleaning

Solvent degreasing is further augmented in metal cleaning by the use of alkalis which, in many ways, are the cheapest and simplest form of degreasing, presenting the least number of problems. General practice is to use a mixture of alkali metal compounds in order to provide the best formulations for use in soak spray and electrolytic cleaners.

The process of soil removal in alkaline solution is principally due to detergency rather than solvency. In alkali emulsion formulations, however, this is not altogether true, since the solvent will assist by solvency. In mixtures of alkali without solvents present, the grease and oil are displaced from a surface rather than by direct solution in the alkali, and may be distributed throughout the body of the alkali in the form of an emulsion which may separate at some stage or, alternatively, partially react with the soil and alkali to form water-soluble soaps, as in the case of fatty soil residues.

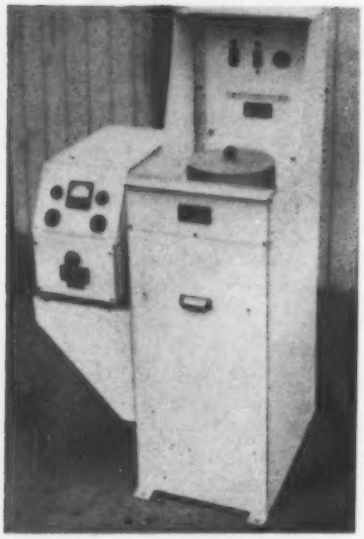
The simplest and most practical, for small scale operations, is a soak cleaning tank. In large scale installations, presenting problems of labour and space, these can be minimized by conveyorizing the plant and, in so doing, the equipment may be adapted to spray cleaning, its efficiency being increased by incorporating a suitable means of agitation. In the electroplating industry, where cleaning standards, of necessity, are higher, the sequence is augmented by the application of an electric current, wherein the article to be cleaned is made either the anode or cathode in the alkali bath.

In soak cleaning systems, the article is simply immersed into the cleaning solution for as long a period as possible, the alkali being maintained at a temperature between 140° and 180°F. Vigorous agitation of the solution is essential in order to provide both a scrubbing action and to ensure that the solution adjacent to the article does not become over-contaminated with grease and so reduce the efficiency of the system.

The tanks are normally constructed of steel, with the concentration of salts in the solution varying between 2 to 16 oz/gal. depending upon the application. It is important to maintain the solutions as free as possible from contaminated greases and oils and for this, various techniques are used, the simplest of which is a manual skimming operation. If the size of plant warrants a more comprehensive system, this should be installed since the surface must be maintained free from these materials for obvious reasons.

The second application of alkali cleaning, that of pressure spraying, is normally associated with conveyorized installations. This technique can be applied to static tank systems, the most significant advantage being the degree of agitation. The efficiency of this system and the plant itself rests upon a satisfactory design with good sighting of the spray nozzles, since it is important that the article to be cleaned is so presented that the major surface be exposed to the direct impingement of the hot alkali or alkali emulsion. Generally speaking, the concentration of chemical used in this application is less than that used for other forms of alkaline cleaning since it is not uncommon to discard the solution more frequently and so reduce accumulation of soil or dirt which could clog spray nozzles, increasing the tendency to produce soaps which, with the high rate of solution movement, accentuates foaming. For this very reason the use of foaming type surface active agents should not be encouraged since excessive foaming can be detrimental to the equipment.

In electrolytic alkaline cleaning, the process is assisted by the use of an electric current wherein the article is made either positive or negative in the alkaline bath. The choice of polarity is, in part, controlled by the metal to be cleaned; in the case of steel, however, either polarity may be used. The efficiency of this system is provided by large volumes of gas generated immediately adjacent to the surface providing a high level of agitation. Cathodic cleaning theoretically produces twice the volume of gas, which may explain the predominance of cathodic cleaning cycles. Where the type of basis metal permits the use of both polarities, this should be incorporated, since a higher standard of surface cleanliness results. Due consideration must, however, be given to the solution composition since specific formulations might work more efficiently on one polarity, but not when used both anodically and cathodically. The use of an electrolytic sequence in a cleaning line has the tendency to reduce time cycles, allowing a greater output per unit. The controlled conditions of temperature, agitation and



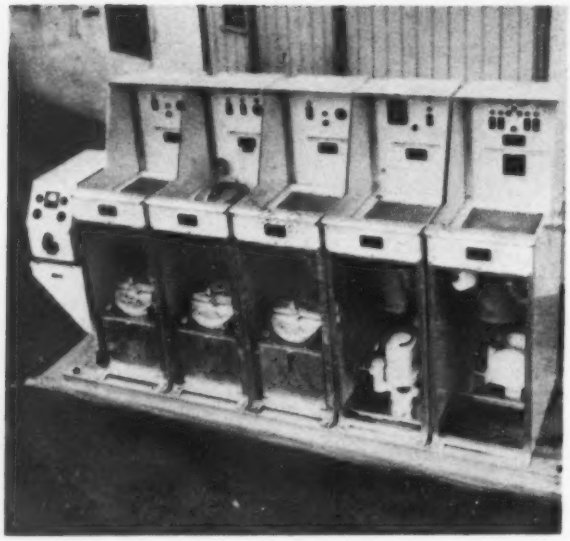


*Fig. 6—Small ultrasonic cleaning unit (left) and multiple unit (right); some of the range manufactured by Electro-Chemical Engineering Co. Ltd.*

solution composition, with attention to solution surface cleanliness, apply as with other alkali cleaning systems.

The increasing importance attached to metal cleaning brought about by a demand for higher quality, has necessitated the development of material compositions incorporating emulsions of various solvents, the most common of which are tricholoroethylene and paraffin. The solvent concentration varies between 2-10 per cent by volume and, because of its specific gravity, forms a blanket on the solution surface; it is hoped by this to accommodate both forms of grease. Unfortunately, emulsions having trichloroethylene as the solvent phase have not found favour in the metal finishing industry, partly because they attack jig coatings and partly because they have not provided the advantages claimed and so do not warrant their additional cost. Where the solvent is used in conjunction with heat, excessive evaporation of the volatile solvent results in the process being very uneconomic in operation.

A special application of alkalis is in the field of alkaline descaling and derusting, the most common of which is the alkali cyanide derusting solution.

In recent years, development of alkali scale removal systems has taken place, the best known of which is the sodium hydride descaling process, which comprises a molten bath containing anhydrous sodium hydroxide to which is added a small quantity of sodium hydride, this acting as a reducing agent. The molten bath is maintained at a temperature of 350-380°C. with reasonably short immersion times, and the process can be used on mild steel, copper, nickel, chromium and the majority of alloy steels. Following immersion in the molten sodium hydride, the article to be cleaned is quenched in water which, for many applications, produces a suitable surface finish; however, this may be assisted by either brushing or acid pickling.

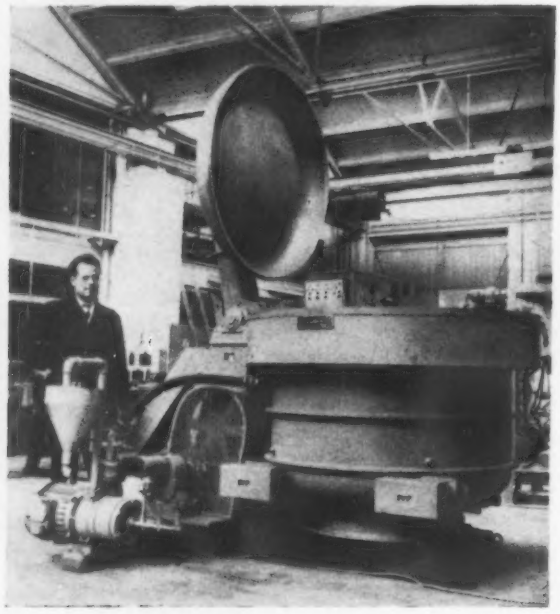


*Fig. 7—Large automatic ultrasonic cleaning plant*

*Courtesy Electro-Chemical Engineering Co. Ltd.]*

## Acid Pickling

The term acid pickling is applied to the chemical or electrochemical removal of surface oxides or scale produced from operations such as heat-treatment and forging, which are applied as an interstage operation for machining and can be used to denote a stage in a cleaning sequence immediately prior to electroplating whereby the article is made the anode in an acid solution.

The tanks must be either made or lined with a material which will resist attack by the acid. It is general, where the article to be pickled has on its surface heat-treatment or forging scale, to heat the solution, which is seldom used above a concentration of 10 per cent. Where the application is part of a precleaning sequence in an electroplating line, more concentrated solutions are used in the case of steel, whilst more dilute solutions are used for the non-ferrous alloys, both being used at room temperature.

The addition of inhibitors in acid pickling processes is extensively used both to limit attack of the acid on the metal surface and to assist in retarding the tendency to produce hydrogen embrittlement in ferrous metals. The mechanism by which inhibitors assist in providing this safeguard is not known. The nature and composition of these compounds vary widely and may comprise either organic or inorganic substances to which frequently, due to their complexity, it is not possible to apply any measure of chemical control.

(*concluded on page* 132)

TECHNIQUES DEVELOPED FOR USE ON STANDARD AIRCRAFT WORKS EQUIPMENT

# Titanium Sheet Forming

By A. T. CARSE and W. T. ARDIS

(*Short Brothers and Harland Ltd.*)

(*Concluded from* METAL INDUSTRY, 10 *February* 1961)

IN drop hammer forming operations, pressings in ICI.130 material were produced for an experimental ducting system. These included elbow and "tee" branch pressings in 26 and 22 gauge material, and circular flanged pressings in 16 and 12 gauge material for duct and joint rings.

Cast Mazak dies with steel draw plates were employed for all pressings. Plywood spacers were used to regulate the amount of draw at each application of the hammer. A typical tool set-up is shown in Fig. 14.

With the exception of the 16 gauge circular pressings, which were produced at room temperature, all the parts were formed from heated blanks, using powdered graphite as a lubricant.

Blanks for hot forming were heated to 430°C. in a portable electric oven. The draw plates were also heated to minimize heat losses.

All formed parts were subsequently stress relieved at 500°C. for periods of 15 to 40 min., depending on material thickness.

The circular flanged parts were satisfactorily formed with depths down to 1¼ in. for diameters ranging from 3¾ in. to 5½ in. Slight flange wrinkling on the 12 gauge parts was removed in a later machining operation.

The 26 gauge "Tee" branch pressing shown in Fig. 15 was formed with spherical ends to help counteract wrinkling and springback tendencies.

The parts produced to this configuration were much superior to those formed with open ends. The trimmed and welded pressings are shown in Fig. 16.

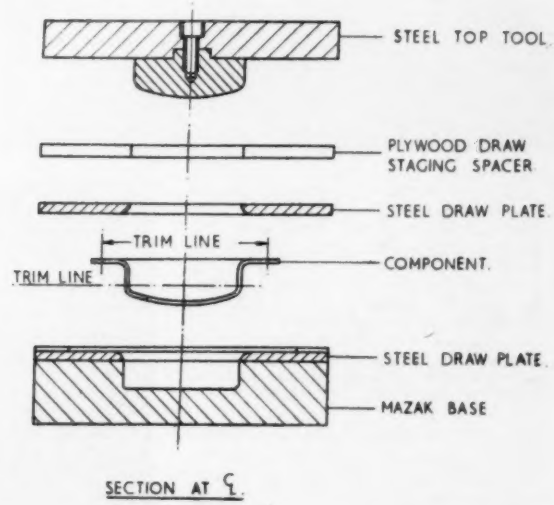



*Fig. 14—Typical tool set-up for drop hammer forming*

## Wheel Forming

Preliminary wheel forming trials were conducted on a small doubly curved panel (Fig. 17). The object of the trials was to assess and compare their formability with a view to producing the anti-icing duct body by this process.

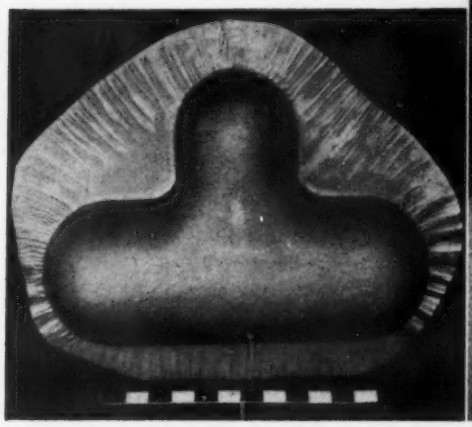
The anti-icing duct body was subsequently successfully formed by wheeling. The time required to produce a titanium duct was approximately treble that required for a light alloy counterpart. This was due, to some extent, to excessive panting present in the sheet. Considerably higher wheel pressures than those employed on light alloy were necessary.

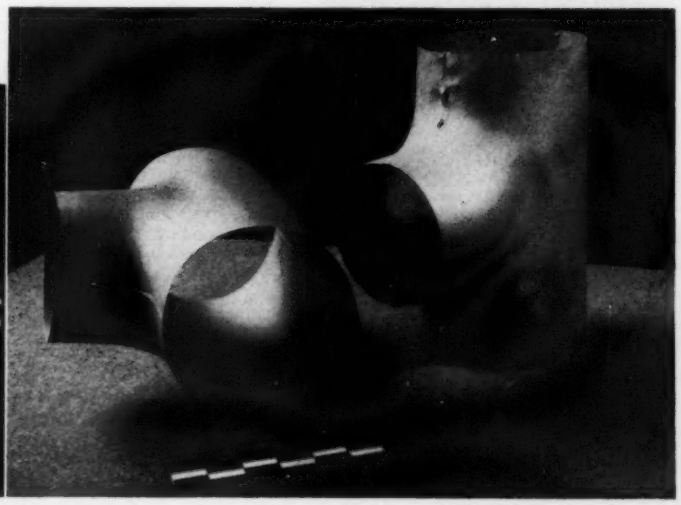
## Drilling

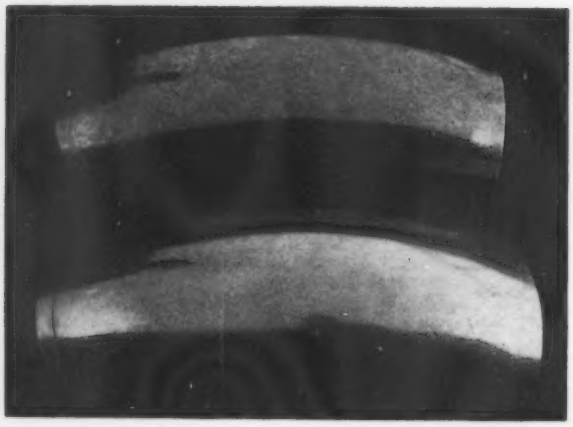
Drilling of light gauge titanium sheet presents a number of problems,

*Below: Fig. 15—Tee-branch pressing, with spherical ends to counteract wrinkling and springback*

*Right: Fig. 16—Trimmed and welded pressings*







*Left: Fig. 17—Double-curvature panels used in preliminary wheel forming trials*

*Below: Fig. 20—Prototype hot dimpling machine*

P.E.R.A. recommended grind for spiral drill. Body is uncleared and black oxide finished. Note:— Cutting edges meet at centre—chisel point is eliminated.

Modified standard black oxide finished drill used in tests. Body clearance retained. Point ground to give zero degree rake angle with reduced lip off-set and chisel point (approx. $\frac{1}{3}$ standard)

*Fig. 18—Drill used in tests on titanium sheet*

triangular holes. Drill life was short and difficulty was experienced in obtaining immediate and accurate point penetration.

Best results were obtained with standard black-oxide finish drills having points ground to incorporate some of the features recommended in a P.E.R.A. publication. These are illustrated in Fig. 18.

Although it was not possible to adhere strictly to all the specifications recommended, results from drilling tests with the modified drills were very satisfactory. Good round holes were produced and drill life was considerably increased. Drilled specimens are shown in Fig. 19.

All drilling in these tests and in subsequent operations on anti-icing duct parts was carried out dry, using a 2,000 r.p.m. pneumatic hand drill.

## Hot Dimpling

A newly developed hot dimpling process has been successfully used for titanium sheet.

The process involves the use of electrically heated dies which are automatically applied to the material in two distinct pressure stages.

In the first stage, the dies make contact with the sheet at primary pressure. This is maintained until the material, under the influence of the heated dies, reaches a set stage of deformation. At this point, full forming pressure is applied and maintained for a brief predetermined period.

An important feature is that the dimpling cycle is fully automatic and is so arranged that it cannot be initiated until the correct die temperature has been reached.

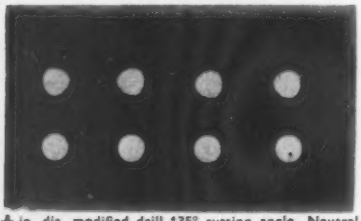
The process has been used in the development of both a static and a portable machine—a prototype of which is shown in operation on a titanium component in Fig. 20.

especially where hand held tools are employed and where bush support for the drill is not practicable.

In initial try-outs on 24 gauge commercially pure sheet, standard $\frac{3}{32}$ in. to $\frac{7}{128}$ in. diameter drills produced rough,

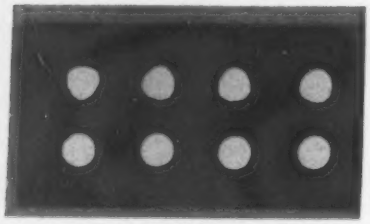
*Fig. 19—Results of drill tests on RC.55*

$\frac{1}{4}$ in. dia. drill as received from stores



$\frac{1}{4}$ in. dia. modified drill 135° cutting angle. Neutral helical angle

$\frac{1}{4}$ in. dia. drill as received from stores



$\frac{1}{4}$ in. dia. modified drill 135° cutting angle. Neutral helical angle

# Cleaning of Surfaces

—*concluded from page* 130

Regular calculated additions are, therefore, normally added along with acid adjustments based on chemical analysis.

## Ultrasonic Cleaning

One of the most important developments of recent years is ultrasonic cleaning. Early attempts at ultrasonic cleaning were unsuccessful due to the inadequate nature of the equipment used; modern plants, however, based on the lessons of earlier failures, provide complete operational sequences enabling rapid continuous high quality cleaning of delicate components on both manual and semi-automatic machines.

Essentially, ultrasonic cleaning plant consists of a tunable ultrasonic oscillator, a powerful amplifier, and a transducer which, in converting electrical energy into acoustic or mechanical energy forms the basis of the process. The solvents are normally chlorinated hydrocarbons, although where lower frequency oscillators are employed aqueous solutions are preferred.

In order to obtain the maximum benefit from any metal cleaning system, either mechanical or chemical, it is necessary to apply some form of either physical or chemical control. The systems discussed in this article require no elaborate apparatus in order to determine the alkalinity or acidity of the wet processes used in metal finishing shops, neither do the mechanical systems require more than a thorough inspection of product at interstages in the cycle. Any alteration in quality can be rectified at an early stage rather than await considerable quantities of scrap at the end of the production line.

The author wishes to thank Wilmot Breeden Limited for permission to publish this article.

# Industrial News *Home and Overseas*

### A Major Expansion

As part of their major programme of expansion and modernization whereby their two existing foundries, which produce a wide range of castings in aluminium and zinc, will be combined in a single large unit, the **Patent Die-Castings Company Limited** have acquired the premises recently vacated by the Light-alloys Company at Park Royal, Willesden, London, and expect to be moving into those premises during the next two months.

This expansion programme will allow the company to increase its capacity by the installation of additional and larger die-casting machines, and the extra space available will provide ample room for the extension of the ancillary departments and services which are considered essential to the production of quality die-castings.

A new office block with an imposing frontage to Chase Road is being planned and when the move is completed a total area of some 95,000 ft$^2$ will be occupied by the company, which is now under the direction of a newly-formed board consisting of **Mr. S. L. Fellows** (chairman), **Mr. L. A. Jarvis** (managing director), **Mr. S. R. F. Hickman, Mr. R. D. Poore** and **Mr. A. J. W. Payne** as directors.

### Fifty-Inch Aluminium Foil

For the first time in Britain, at the International Packaging Exhibition, to be held at Olympia, London, in September this year, the **Star Aluminium Company** will be showing examples of the 50 in. (1·27 m.) aluminium foil, claimed to be the widest foil in Britain, which is made at the company's new Bridgnorth rolling mills.

### Welding News

To coincide with the Engineering, Marine, Welding and Nuclear Energy Exhibition, to be held in April next, the 1961 Spring Meeting of the **Institute of Welding** will be held in London between April 25 and 28. The theme of the meeting will be "Recent Developments in the Welding and Allied Processes".

### Explosion Hazards Overcome

Explosion hazards which may occur when mixing certain volatile liquids and organic materials have been minimized by the development of the Waring explosion-proof Blendor motor base. This high-speed base, which mixes at speeds of 8,000 or 16,000 r.p.m., is being marketed in this country, prior to later manufacture in Britain, by the Waring Division of **Winston Electronics Ltd.** on behalf of the Waring Products Corporation of New York, a sister subsidiary of the Dynamics Corporation of America.

Fire and minor explosions are most frequently caused when inflammable liquids and solids are mixed by the vapour in the immediate atmosphere becoming ignited from the arcs of the electric motor brushes, or when the mixture is accidentally spilt. The chemicals, many of which produce inflammable vapours, with which this equipment is being constantly used in the U.S.A., include petrol, naphtha, benzine, butane, propane, alcohol, acetone, benzol, natural gas or solvent vapours and the resultant blended products include petroleum-based lubricants, petroleum ether, ethyl ether, paints, low vapour gasolene, acetone, methyl alcohol, ethyl alcohol, benzine, toluene, isopropyl alcohol and unstripped latex.

### Lead and Zinc in Poland

A new Polish lead and zinc combine is to be erected at Miasteczko Slaskie, in the Tarnowskie Gory district of Poland, according to the Swedish-Polish Chamber of Commerce in Stockholm. Production will partially commence in 1964-65 and the plant will be fully productive by 1967-8. Equipment for the new plant will, in the main, be produced in Poland, but some special equipment will be imported from West and East Germany and the United Kingdom.

### French Aluminium Exports

It was stated in Paris recently that French aluminium exports totalled 69,000 tons in 1960, against 33,284 in 1959. Belgium received 33,000 tons against 16,735 tons, the United States 14,000 tons against 3,140, Argentina 2,700 tons against 1,526, West Germany 1,500 tons against 999, and Italy 800 tons against 801.

### Consolidated Zinc

An interesting and well illustrated brochure of over 80 pages has just been produced by the **Consolidated Zinc Corporation Limited.** In its pages is told the story of a thriving Anglo-Australian partnership, the seed of which was sown at Broken Hill with the formation of the Zinc Corporation in 1905. It developed, through the Imperial Smelting Corporation, the zinc industry in the United Kingdom following the first World War, and has since grown into the many-sided activities of the C.Z.C. group of companies.

The brochure describes the progress in mining achieved at Broken Hill, and also the present practices of lead smelting, zinc smelting and acid production in Australia and the U.K. Other facets of the group's activities are also revealed—the recovery of minerals from beach sands on Stradbroke Island, off the coast of Queensland, the developments in fluorine chemistry, the success of the Imperial Smelting blast-furnace process, the bauxite investigations in the Cape York Peninsula, and operations in Canada.

Although a brochure of this size cannot tell the complete story it does, in fact, with the assistance of many excellent coloured photographs, give many instances of the progress achieved by the group, and also outlines the possibilities for future growth and diversification of the group's undertakings. It is a work well worth reading.

### A Special Lecture

Readers are reminded that on Thursday next, February 23, **Professor W. Hume-Rothery,** O.B.E., F.R.S., of Oxford University, is to give a lecture on "The Theory of the Alloys of Copper" under the auspices of the Metal Physics Committee of the Institute of Metals.

The meeting will take place at the Royal Institution, Albemarle Street, London, W.1, at 6.30 p.m. Visitors will be welcome and no tickets of admission are required.

### Fuel-Container Testing

With the increasing use of liquid fuels in industry come the attendant problems of handling and safe storage. Tanks corrode and, eventually, leak; alterations are made to plant calling for a changeover in grades of fuel oil, and rebuilding and development cause changes in siting of storage. With solid fuels, no serious problem arises, but alterations to liquid fuel installations call for expert knowledge and special techniques.

The firm of consulting chemists and analysts, **Ernest A. Lewis and Co. Ltd.,** have extended their services to cover these problems. The testing, degassing and cleaning of oil, petrol and paraffin storage tanks are being carried out by a separate department under the supervision of trained chemists. The larger petroleum distributors are making full use of this service as it forms an excellent safeguard against accident, and several firms of heating engineers are regularly seeking advice on tricky problems.

### Miniature Thermocouples

Two new miniature thermocouple wires have been added to the range of "Thermocoax" miniature thermocouple wires manufactured by **Research and Control Instruments Limited,** with outside diameters of 0·34 mm. and 0·25 mm. They are of "Chromel-Alumel" in stainless steel sheaths, and are available in limited continuous lengths of up to 6 metres. Type numbers are 2ABAC034 and 2ABAC025 respectively.

### Die-Casting Discussion Group

In November last year, twelve leading British die-casting engineers and metallurgists left for a visit to the United States arranged by the Zinc Alloy Die Casters Association. They attended the First National Die Casting Exposition and Congress held in Detroit by the Society of Die Casting Engineers, as well as a "Clinic Exhibit" organized by members of the American Die Casting Institute in Hartford, Connecticut. On Tuesday last week (February 7) some of those who had made the trip spoke to an audience of 150 from the staff of 23 member firms at the third of the association's technical discussion meetings. **Mr. Reg Turner** of Metal Castings Ltd. took the chair, and the meeting was held in the New College of Technology, Birmingham.

The chairman of the association, **Mr. J. A. Goddard** (Fry's Die-castings Ltd.), described the scope of the tour, and **Mr. L. A. J. Lodder** (Imperial Smelting Corporation Ltd.) talked about the improved types of chromium plating now being used for finishing die-cast external components of American cars. **Mr. G. P. Welch** (Wolverhampton Die Casting Co. Ltd.) described various alloying and metal melting techniques that he had seen, and **Mr. R. P. Bryan** (Metal Castings Ltd.) gave a first-hand account of the operation of giant die-casting machines with a locking force of 2,000 tons which are casting six-cylinder engine blocks for

American Motors, a subject which prompted much discussion. The audience questioned the speakers closely on many points of American practice, and it was clear that the various techniques in die making, machine operation, etc., had been developed to a different degree in the two countries. This emphasizes the value of the technical exchange visits which associations can arrange for their members.

### News from Scotland

It is reported that **Colvilles Ltd.**, of Motherwell, have come to an agreement with Republic Steel Corporation of U.S.A. to exchange technical information and to exploit markets and other common interests. Training of staff from the new Ravenscraig mill will be undertaken in the U.S.A. and some Colvilles key workers have already transferred there for training.

A start is to be made next month on the construction of the **Skefko Ball Bearing Company's** new factory at Shewalton, Irvine, where 150 acres have been earmarked for this development. The new plant will produce components, accessories and machinery of special type, for use in the ball bearing manufacturing field, and will co-ordinate production with the main factory at Luton.

The steady decline of employment in the foundry industry in Scotland is causing concern to employers and the Amalgamated Union of Foundryworkers. It is said that some 5,000 workers have been lost to the foundry industry in Scotland over the past ten years as a result of decreased demand, expansion of the industry in the English Midlands which has attracted labour away, and the concentration of older units into more modern centralized premises.

### Epoxy Flooring Composition

A new flooring composition developed by **Tretol Ltd.**, under the name of Tretol Epiflor, has recently been introduced to cope with the "difficult" floor areas which create perpetual maintenance problems in many factories.

This new composition is a combination of special resins and aggregate which, it is said, will adhere strongly to all floors. It gives a coloured, non-slip topping, ¼ in. thick, which is resistant to chemicals, oils and acids, and, having exceptional abrasion resistance, it withstands extreme hard wear by foot traffic, trolleys and trucking, and is easily laid by own maintenance staff.

The makers state that Tretol Epiflor is especially suitable for use in chemical plants, plating and pickling shops, laboratories, tanning plants and phosphating shops where the floors are attacked by corrosive substances and oils.

### New Copper Plating Process

Recent work in the **Albright and Wilson (Mfg.) Ltd.** laboratories has resulted in the development of a new electrolyte based on pyrophosphate for copper plating. The main feature of this "Pyrobrite" bath is the new PY61 addition agent. This is said to ensure fully bright deposits over a wide current density range. The bath also has outstandingly good levelling characteristics and produces close-grained, smooth deposits, which do not finger-mark or spot out.

Another special feature of this bath, say the manufacturers, is that as it contains no cyanide there is no need for fume extraction and there are no problems associated with the disposal of effluent. The solution itself is only mildly alkaline and does not attack light alloys to any appreciable extent.

We are also informed that another important application for the Pyrobrite process is in copper plating prior to bright nickel and chromium plating of zinc-based die-castings and steel. The good levelling properties of the solution often make it possible to eliminate mechanical polishing of the base metal before nickel plating directly on to the copper. A "strike" solution based on copper pyrophosphate is available for articles made of steel.

### Scottish Depot

Makers of "Presto" engineering small tools, **Easterbrook, Allcard and Company Ltd.** are extending their depot service to Scotland, where the first branch is to be opened at the beginning of April.

The manager of the new branch at 74 York Street, Glasgow, will be Mr. J. H. S. Lamb, who recently returned from Malaya to join the company.

### Change of Name

It has been announced by Audley Engineering Company Ltd. that, with effect from March 1 next, the name of the company will be changed to **Audco Limited.**

### U.K. Metal Stocks

Stocks of refined tin in London Metal Exchange official warehouses at the end of last week fell 42 tons to 10,098 tons, comprising London, 4,272, Liverpool 3,891 and Hull 1,935 tons.

Copper stocks fell 645 tons to 14,975 and were distributed as follows: London 950, Liverpool 11,600, Birmingham 100, Manchester 2,275 and Hull 50 tons.

Lead duty free stocks fell 87 tons to 7,263 tons, while in bond stocks were unchanged at 3,892 tons. All supplies were in London.

Zinc duty free stocks fell 135 tons to 2,980 tons, while in bond stocks were unchanged at 525 tons, comprising London duty free 1,189 tons and in bond 525 tons, Liverpool duty free 1,751 tons and in bond nil tons, Glasgow duty free 40 tons and in bond nil tons.

### World Outlook

In its review of non-ferrous metals outlook, the **British Metal Corporation** foresees a surplus of copper in 1961 of some 150,000 tons. The course of the lead market in 1961 greatly depends on the meeting of the Study Group in March, but modest increases in consumption, combined with a more effective cutback in production, should suffice to rally the market. The review expects world zinc consumption to rise in 1961 and the market to continue on its present healthy basis. With tin, the position is in doubt, but there will probably be a small shortage. The largest proviso in these predictions is whether there will be a revival of business in the U.S. in the spring.

Copper output in 1961 is estimated at 4,150,000 tons against consumption of 4,000,000 tons. Output totalled some 4,100,000 tons in 1960, while consumption reached an estimated 3,880,000 tons. World mine potential is put at 4,400,000 tons for 1961. The tentative conclusion from all this, the review states, is that the announced cuts in output may not quite suffice to bring the position fully into balance in 1961. Moreover, stocks in the industry have already been built up to ample proportions. Looking further ahead, however, there is good promise of riding out the copper surplus. Whereas nearly 1,000,000 tons of new capacity have been provided in the industry since 1955, extensions to capacity in the next two years may run to about 70,000 tons/year. Usage of copper, on the other hand, should grow faster than this, provided that world economic activity is maintained.

The review notes that the market surplus in lead has not been eliminated and prices have sagged, despite the restraint of producers in selling lead. Two main problems face the Study Group when it meets in Mexico City in March. It must try, first, to secure undertakings to cut output rather than merely to check the flow of supplies to the market; and, secondly, to share the burden of curtailment between the producers more precisely and fairly. In 1961, there may be some recovery of consumption in the U.S., perhaps to the 1959 level, and a further modest expansion in other countries taken together. Such increase, coupled with a more effective cutback in output, should suffice to rally the market.

World zinc consumption in 1961, according to the review, should surpass 3,000,000 tons, especially if there is a business recovery in the U.S. in the spring. Supplies are expected to increase by some 100,000 tons. If the strong growth of free world consumption is continued—and this will be more likely if and when U.S. consumption goes ahead again — the much sounder basis of the industry will be preserved. Therefore the review advocates careful consideration before further measures of artificial support are pressed.

Tin consumption of the free world in 1961 should exceed the 1960 level of 172,000 tons, if the expected U.S. recovery takes place in the spring. Total estimated supplies in 1961 will be 167,000 tons. This figure does not take into account any stocks available for export, but these are held to be small. However, the review points out, the indications are not very decisive and it seems a situation in which one must await further evidence from the market itself. It remains to be seen at which end of the £780-£830 price range prices will be more severely tested. There are potential barriers at both ends. At the lower, renewed buffer stock buying and re-imposed export control and at the top end buffer stock selling and a possible Canadian Government disposal of 3,000 tons.

### Tin in Chile

News from Santiago states that the Chilean firm, Compania Explotadora de Minerales de Chile, has requested U.S. firms to make a geological survey of an area in the Province of Antofogasta where, according to reports, a valuable tin deposit has been discovered. The reports added that samples show the ore to be of excellent grade, comparable to that mined in the Catavi mines in Bolivia.

Meanwhile, six German technicians have arrived in Chile to carry out drillings as a preliminary to the development of a copper mine at Andacollo, in the Province of Coquimbo. The deposit will be jointly operated by the Mansfeld Company of Germany and the Chilean firm Tamaya S.A.

Empresa Nacional de Mineria, a semi-state agency, has announced that it will sell abroad 2,515 tons of lead ores and concentrates. The Foreign Commerce

Department, it was stated, had already authorized a quantity of lead ore to Germany valued at $136,405.

**Copper in Netherlands New Guinea**

Copper and gold have been found in Netherlands New Guinea, according to a press report from Amsterdam. The report said the finds had been made by an expedition in the Carstensz Mountains and a detailed study of the resources would be made by the "Oostborneo Maatschappij NV" (East Borneo Company Limited), a Dutch concern, and the United States Company, Freeport Sulphur Company.

The copper has been found in the mountains at a height of 3,500 metres, and provisional estimates put possible production at 40,000 tons a year. It is hoped that exploitation can start in two years' time. Drillings will be started this year to determine the depth of the ore deposits.

**U.S.A. Aluminium Exports**

Exports of crude aluminium from the U.S.A. increased to 570,000,000 lb. in 1960, more than double the 1959 total of 242,200,000 lb., while imports declined by about 35 per cent to 309,400,000 lb., the Department of Commerce reported. The gains were largely due to newly opened U.S. Aluminum Company subsidiaries in the United Kingdom and to liberalized West German import quotas, the Department said. Inventory reductions accounted for the fall in U.S. imports.

Shipments to the U.K. were up by 115 per cent, from 110,100,000 lb. to 235,200,000 lb. The West German purchases tripled from 37,600,000 to 151,200,000 lb. France, Yugoslavia, Japan and the Netherlands were among other countries to which crude aluminium shipments increased.

**Tin in Malaya**

Malaya's stock of tin metal and tin-in-concentrates at the end of December, 1960, amounted to 12,664 tons, according to the chief statistician. This compared with end-November stocks of 13,292 tons. The chief statistician also stated that in 1960 Malaya produced 51,979 tons of tin-in-concentrates, against 37,525 tons in 1959.

**Metal Fabricating in Australia**

Two associated eastern States companies will spend more than £500,000 in establishing a non-ferrous metal fabricating and cable industry in Western Australia, according to Mr. D. Brand, Western Australian Premier. Metal Manufactures Ltd. and Cable Makers Aust. Pty. Ltd. will begin construction immediately of adjacent factory buildings on a 40-acre site at Melville, seven miles from Perth.

Mr. Brand said Metal Manufactures would build a factory to produce copper wire and strand and annealed copper tubing, which would meet all Western Australia's needs for wire, tubes and cable from virgin metal and other raw materials to the finished products. Metal Manufactures is the principal of associated companies which, together, make up Australia's biggest non-ferrous fabricating group.

**A Golfing Event**

For its annual golf tournament, the **Non-Ferrous Club Golfing Society** is meeting again this year at the Stratford-upon-Avon Golf Club, the date fixed for the meeting being Tuesday, June 20. As in previous years, the competition will be open to members of the society and their guests, and to other players connected with the industry.

Further details can be obtained from Mr. R. L. Deutsch, Alliance Works, Harford Street, Birmingham, 19.

**The P.O.A. Minibition**

Early notice is given of the **Purchasing Officers Association Minibition,** to be held this year at the Hotel Metropole, Brighton, from September 28-30. This event is being held in conjunction with the association's annual conference in the same building. This Minibition provides an excellent opportunity for industrial companies to show their products to buyers in an informal and leisurely atmosphere.

The stands are prefabricated, platform size 5 ft. by 3 ft., two types being available, for table height or floor display, and in view of the limited amount of space no exhibitor may have more than two stands. The stand hire charge is £25 for the full period, and readers who would like further details should write to the secretary of the association at Wardrobe Court, 146A Queen Victoria Street, London, E.C.4.

**Soviet Exhibition in London**

The latest machinery used in the Soviet non-ferrous metals industry will be seen at the large Soviet Trade and Industry Exhibition, opening at Earl's Court on July 7 for three weeks. The non-ferrous and ferrous metals industry will take up more than 4,300 sq. ft. out of a total exhibition space of 224,880 sq. ft.

Mr. Alexandre Saag, Director of Soviet Foreign Trade Exhibitions, states that during the Exhibition either the President or Vice-President of the Soviet Raznoimport trading agency—which handles the import and export of all non-ferrous metals—will be in London for talks with British business men. All the machinery on show will be for sale. Russian technicians will also be available to explain the detailed workings of the equipment.

**Metallurgy of Beryllium**

A three-day International Conference has been organized by the **Institute of Metals** to take place in London on October 16, 17 and 18 this year, on the theme of "The Metallurgy of Beryllium". The intention is to publish and discuss a great mass of hitherto unpublished original work on beryllium, and to cover metal fabrication, physical and mechanical properties, and metal physics — in fact, the whole field of the metallurgy of beryllium with the exception of extraction processes.

Papers will be issued in preprint form in advance of the conference, and will later be published promptly, together with reports of the discussions, in bound form. Full details of this event may be obtained from the secretary to the institute at 17 Belgrave Square, London, S.W.1.

**A.S.E.E. Exhibition**

A comprehensive display of all types of rectifier made by **Westinghouse Brake and Signal Company Limited** will feature Westalloy copper-oxide units, new process Westalite selenium, germanium and silicon power diodes, and high power Trinistor silicon switching devices at the Electrical Engineers Exhibition, to be held at Earl's Court, London, next month.

All of these types will be shown embodied in various completed equipments on display, illustrating the very extensive applications of controlled A.C. and D.C. power supplies employing Trinistors.

Many complete rectifier equipments will be on view, including examples of low voltage heavy current power supplies for electrochemical processes, industrial medium voltage equipments, and a 1,000 kW silicon rectifier for railway traction supply on multiple unit stock.

## Forthcoming Meetings

**February 20 — Institute of British Foundrymen.** East Anglian Section. Lecture Hall, Public Library, Ipswich. "Developments in the Production of Gunmetal Castings." F. Hudson. 7.30 p.m.

**February 20—Institute of Metal Finishing.** London Branch. Northampton College of Technology, St. John Street, London, E.C.1. "Some Electroplating Problems in Mould Electroforming." P. Spiro. 6.15 p.m.

**February 21—Institute of Metal Finishing.** South-West Branch. Saracen's Head Hotel, Gloucester. "Electrochemical Machining." D. Hughes. 7.30 p.m.

**February 21—West of England Metallurgical Society.** College of Technology, Ashley Down, Bristol, 7. "Metallurgy in Modern Jewellery." Miss Dorothy Pile. 7.30 p.m.

**February 22 — Society of Instrument Technology.** South Wales Section. Newport and Monmouthshire College of Technology, Newport. "The Manufacture, Properties and General Uses of Metal Bellows." R. W. Houghton. 6.45 p.m.

**February 22 — Manchester Metallurgical Society.** Manchester Literary and Philosophical Society, George Street, Manchester. "Metallurgical Applications of Radioisotopes." Dr. M. C. Inman. 6.30 p.m.

**February 23—Institute of Metals.** Royal Institution, Albemarle Street, London, W.1. "The Theory of the Alloys of Copper." Professor W. Hume-Rothery. 6.30 p.m.

**February 24—Institute of Metal Finishing.** Sheffield and North-East Branch. Grand Hotel, Sheffield. "Chelating Agents in Metal Treatment." J. K. Aiken. 7 p.m.

## Obituary

### Mr. J. H. Aston

IT is with regret that we have to record the death, at the age of 90, of John Herbert Aston, who was one of the leading industrialists of his generation in the Midlands. After a number of years with Tubes Ltd., of Aston, Birmingham, of which firm he was managing director, he became joint founder of Tube Investments Ltd., which merged the interests of Tubes Ltd., Bromford Tube Company, Accles and Pollock Ltd., Simplex Conduits Ltd., and other companies. He was the first managing director of Tube Investments Ltd., and in 1941 he became chairman, a position he held until 1944. He retired in 1947. From 1930 to 1944 Mr. Aston was a director of Stewarts and Lloyds Ltd. He was a life member of the Iron and Steel Institute, and a life governor of Birmingham University.

# Metal Market News

ALTHOUGH it would not appear that consumer participation last week was on anything like a big scale, active conditions prevailed on the Metal Exchange, where the turnovers were fully up to average. Indeed, the amount of business transacted in tin was above the average, for the turnover was not much short of 1,450 tons. In copper, too, some 15,000 tons of sales were made, and this did not include deals put through on the Kerb. In addition to details of stocks of copper and tin, the Exchange has furnished from the beginning of this year the tonnage in respect of lead and zinc, so that all four are now available. Last Monday, the following figures were given for tonnage in L.M.E. official warehouses at the end of the previous week: copper, minus 240 tons, to 15,620 tons; tin, plus 133 tons, to 10,140 tons; lead, plus 589 tons, to 11,242 tons; and zinc plus 263 tons, to 3,640 tons. Contrary to the opinions expressed in some directions at the time the changes in the lead and zinc contracts were made, growth in stocks has not been checked, and for some weeks now there has been a steady increase. The stock situation is reflected in the comparison of the prompt and forward prices, for a contango rules in copper, tin and lead, while there is a backwardation in zinc, of which there are less than 4,000 tons in stock. Actually, the contango in copper improved last week from 25s. to £2 and, in due course, it may grow wider.

For the moment, however, there is another strike scare from Chile, for a report from El Teniente to hand last Friday gave information of fresh demands from the workers in respect of payment for the time spent in travelling to and from the job. Moreover, there was a shut-down of the ore crusher, due to a decision to cease work, but it is hoped this will not be of long duration. This news from South America was enough to hoist the market a couple of pounds on Friday, following a decidedly easy tendency on the previous day. This may be regarded as action taken by operators with a short position open on the market, and it does not follow that a serious shut-down is going to take place. Towards the end of the week things looked rather better in the United States, and the export quotation stiffened slightly. Scrap was reported as rather short on the domestic market in America, and the custom smelters quotation was fully steady.

The turnover on the standard copper market has already been mentioned. As to the movement in the price, this amounted to a rise of 25s. in cash to £220 15s. 0d., and of £2 in three months to £222 15s. 0d. At one time in the week, a moderate enquiry was reported from the Continent. Due to a report that a major U.S. zinc producer has decided to reduce production, and expectations that next month may see an extension of this action, the price of zinc rose sharply last week to finish £3 12s. 6d. up for cash at £83, and £2 12s. 6d. better for forward at £81 15s. 0d. The turnover was 8,725 tons. Lead also improved, cash gaining 10s. to £65, and three months 12s. 6d. to £66 5s. 0d. Some 5,200 tons changed hands. Tin was an active market, with a turnover of 1,430 tons, but little change was seen in the price, cash losing £1 to £787 10s. 0d., while three months was unchanged at £790 10s. 0d.

**Birmingham**

In the non-ferrous metal-using trades in the Midland area, conditions are rather quiet. Most firms are operating below the level of 1960, but that was for many an exceptional year due to the high level of demand which was sustained over practically the whole period. There is not much change in the motor trade. Many workers are on short time and there is no noticeable improvement in the outlook. Demand for household goods is keeping up fairly well. Electrical engineers handling heavy equipment are well situated for work. A moderate trade is being done in metal pressings and stampings for shipbuilding work.

Building activity is responsible for the high output of structural steel. Demand for reinforcing bars is still exceptionally high, and delivery takes longer than for ordinary small bars and sections. Output of sheets has been cut because of the reduced needs of the motor trade. For a similar reason, there is less activity at some of the iron foundries. Semi-finished steel is in ample supply. It seems likely that imports will be on a small scale during the current quarter. Demand for basic pig iron for steel production is strong.

**New York**

During the weekend, copper futures were quiet. The undertone was about steady. Traders noted, however, that the undertone in dealer copper was firmer. Most offerings were held at 28¾ cents/lb. Export copper was also slightly firmer. Custom smelters indicated quiet conditions, while producers noted little change in their sales situation, which continued to be of a routine nature. Trade sources believed that the African situation was keeping copper basically steady. Scrap copper prices were unchanged, but offerings were more plentiful. Tin was quiet and steady. Lead was quiet. In zinc, light sales were reported at an average price basis.

American Zinc, Lead and Smelting Company has stated that it plans to cut production of metallic zinc during the first half of 1961 by 10 per cent below levels of a year ago. To do so, it has discontinued production at three Tennessee mines and an Illinois smelting plant. The company listed "heavy inventories of zinc products accumulating under present economic conditions" as the reason for the curtailment. Other shutdowns are expected over the next few months in order to effect the planned production cut.

During the first six months of 1961, American Zinc produced approximately 73,700 tons of metallic zinc. First half 1961 production is aimed at 10 per cent under this amount.

**Canada**

According to news from Montreal, the Canadian Stock Exchange will start trading in silver futures in about 10 days, making the Exchange the only one outside London to list silver futures. Exchange officials said the decision to list the futures derived from increasing interest in silver, due to the imbalance in consumption and production. World silver consumption last year was estimated to have exceeded production by more than 100,000,000 oz.

The establishment of a second market for silver futures was expected to increase prices, with a resulting benefit to Canadian silver producers, Exchange officials said. The first contract months for trading would be this May, with every second month after being a contract month, and trading limited to one year in advance. Spot trading was expected to start later in May.

**Chile**

Chilean copper output during 1960, comprising large, medium and small mining industries, totalled 532,000 metric tons, compared with 545,000 metric tons in 1959, according to figures released in Santiago by the Copper Department.

Of a total of 481,986 tons sold to foreign markets in 1960, 48,391 tons were sent to the United States. In the previous year, 442,106 metric tons were exported, including 96,737 tons to the United States.

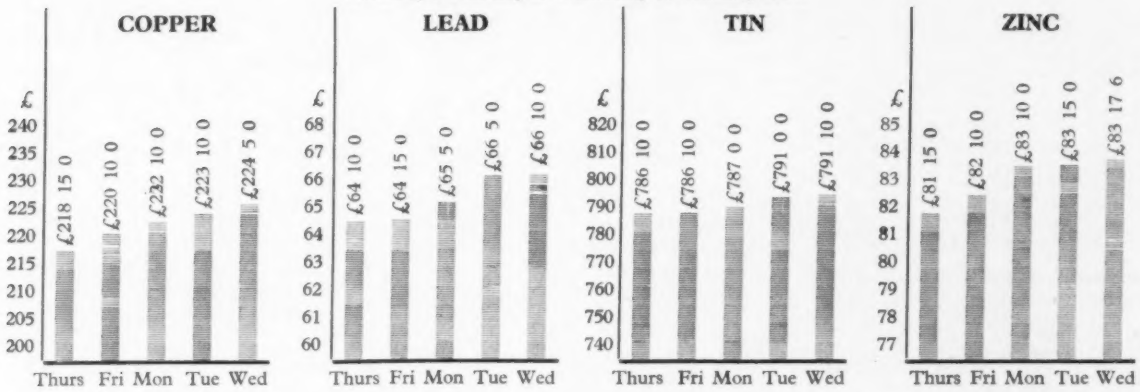
Last year's copper output produced $192,639,507 in taxes and returns for the Chilean Treasury. The Copper Department pointed out that the lower output in 1960 by the large mining companies was due to strikes at the El Salvador, Poterillos and Chuquicamata mines.

It was announced in Washington at the week-end that the Chilean Government had obtained International Monetary Fund approval for an immediate drawing of $16 m. of Argentine pesos.

# Non-Ferrous Metal Prices

## London Metal Exchange

Thursday 9 February to Wednesday 15 February 1961




## Primary Metals

All prices quoted are those available at 2 p.m. 15/2/61

| | | £ | s. | d. |
|---|---|---|---|---|
| **Aluminium** Ingots | ton | 186 | 0 | 0 |
| **Antimony** 99·6% | „ | 217 | 10 | 0 |
| **Antimony** Metal 99% | „ | 210 | 0 | 0 |
| **Antimony** Oxide Commercial | „ | 194 | 10 | 0 |
| **Antimony** White Oxide | „ | 196 | 0 | 0 |
| **Arsenic** | „ | 400 | 0 | 0 |
| **Bismuth** 99·95% | lb. | | 16 | 0 |
| **Cadmium** 99·9% | „ | | 11 | 0 |
| **Calcium** | „ | 2 | 0 | 0 |
| **Cerium** 99% | „ | 15 | 0 | 0 |
| **Chromium** | „ | | 6 | 11 |
| **Cobalt** | „ | | 12 | 0 |
| **Columbite** per unit | | 8 | 15 | 0 |
| **Copper** H.C. Electro | ton | 224 | 5 | 0 |
| Fire Refined 99·70% | „ | 223 | 0 | 0 |
| Fire Refined 99·50% | „ | 222 | 0 | 0 |

| | | £ | s. | d. |
|---|---|---|---|---|
| **Copper Sulphate** | ton | 76 | 0 | 0 |
| **Germanium** | grm. | | — | |
| **Gold** | oz. | 12 | 11 | 2 |
| **Indium** | „ | | 10 | 0 |
| **Iridium** | „ | 24 | 0 | 0 |
| **Lanthanum** | grm. | | 15 | 0 |
| **Lead** English | ton | 66 | 10 | 0 |
| **Magnesium** Ingots | lb. | | | |
| 99·8% | „ | | 2 | 2½ |
| 99·9+% | „ | | 2 | 3 |
| Notched Bar | „ | | 2 | 9½ |
| Powder Grade 4 | „ | | 6 | 1 |
| Alloy Ingot, AZ91X | | 1 | 11½-2 | 1½ |
| **Manganese** Metal | ton | 280 | 0 | 0 |
| **Mercury** | flask | 69 | 0 | 0 |
| **Molybdenum** | lb. | 1 | 10 | 0 |
| **Nickel** | ton | 600 | 0 | 0 |
| F. Shot | lb. | | 5 | 5 |
| F. Ingot | „ | | 5 | 6 |
| **Osmium** | oz. | | nom. | |
| **Osmiridium** | „ | | nom. | |

| | | £ | s. | d. |
|---|---|---|---|---|
| **Palladium** | oz. | 9 | 0 | 0 |
| **Platinum** | „ | 30 | 5 | 0 |
| **Rhodium** | „ | 46 | 0 | 0 |
| **Ruthenium** | „ | 16 | 0 | 0 |
| **Selenium** | lb. | 2 | 6 | 6 |
| **Silicon** 98% | ton | 122 | 0 | 0 |
| **Silver** Spot Bars | oz. | | 6 | 7⅛ |
| **Tellurium Sticks** | lb. | 2 | 0 | 0 |
| **Tin** | ton | 791 | 10 | 0 |
| ***Zinc** | | | | |
| Electrolytic | ton | | — | |
| Min 99·99% | „ | | — | |
| Virgin Min 98% | „ | 83 | 8 | 9 |
| Dust 95/97% | „ | 125 | 0 | 0 |
| Dust 98/99% | „ | 131 | 0 | 0 |
| Granulated 99+% | „ | 108 | 8 | 9 |
| Granulated 99·99+% | „ | 123 | 16 | 3 |

**Duty and Carriage to customers' works for buyers' account.*

## Foreign Quotations

Latest available quotations for non-ferrous metals with approximate sterling equivalents based on current exchange rates

| | **Belgium** fr/kg≏£/ton | **Canada** c/lb≏£/ton | **France** fr/kg≏£/ton | **Italy** lire/kg≏£/ton | **Switzerland** fr/kg≏£/ton | **United States** c/lb≏£/ton |
|---|---|---|---|---|---|---|
| **Aluminium** | | 26.00 215 16 | 2.43 179 11 | 370 216 1 | 2.50 206 5 | 26.00 207 4 |
| **Antimony** 99.0 | | | 2.30 170 0 | 495 286 3 | | 29.00 231 2 |
| **Cadmium** | | | 15.75 1,069 0 | | | 150.00 1,195 10 |
| **Copper** | | | | | | |
| Crude | | | | | | |
| Wire bars 99.9 | | | | 420 245 5 | | |
| Electrolytic | 30.25 223 11 | 27.50 222 15 | 3.05 225 7 | | 2.83 231 0 | 29.00 231 6 |
| **Lead** | | 10.00 81 0 | .94 69 9 | 163 95 3 | .83 68 9 | 11.00 87 13 |
| **Magnesium** | | | | | | |
| **Nickel** | | 70.00 581 0 | 9.00 665 2 | 1,200 699 6 | 7.50 618 15 | 74.00 589 15 |
| **Tin** | 109.50 800 6 | | 11.15 823 19 | 1,480 864 6 | 9.58 805 12 | 100.37 799 18 |
| **Zinc** | | | | | | |
| Prime western | | 12.00 99 12 0 | | | | |
| High grade 99.95 | | 12.60 104 11 0 | | | | |
| High grade 99.99 | | 13.00 107 18 0 | | | 1.10 92 10 | |
| Thermic | | | 1.20 88 13 | | | |
| Electrolytic | | | 1.28 94 13 | 181 105 14 | | 13.00 104 0 |

# Non-Ferrous Metal Prices (continued)

## Ingot Metals

All prices quoted are those available at 2 p.m. 15/2/61

| | | £ | s. | d. |
|---|---|---|---|---|
| **Aluminium Alloy (Virgin)** | | | | |
| B.S. 1490 L.M.5 | ton | 210 | 0 | 0 |
| B.S. 1490 L.M.6 | „ | 202 | 0 | 0 |
| B.S. 1490 L.M.7 | „ | 216 | 0 | 0 |
| B.S. 1490 L.M.8 | „ | 203 | 0 | 0 |
| B.S. 1490 L.M.9 | „ | 203 | 0 | 0 |
| B.S. 1490 L.M.10 | „ | 221 | 0 | 0 |
| B.S. 1490 L.M.11 | „ | 215 | 0 | 0 |
| B.S. 1490 L.M.12 | „ | 223 | 0 | 0 |
| B.S. 1490 L.M.13 | „ | 216 | 0 | 0 |
| B.S. 1490 L.M.14 | „ | 224 | 0 | 0 |
| B.S. 1490 L.M.15 | „ | 210 | 0 | 0 |
| B.S. 1490 L.M.16 | „ | 206 | 0 | 0 |
| B.S. 1490 L.M.18 | „ | 203 | 0 | 0 |
| B.S. 1490 L.M.22 | „ | 210 | 0 | 0 |
| **Aluminium Alloys (Secondary)** | | | | |
| B.S. 1490 L.M.1 | ton | 171 | 0 | 0 |
| B.S. 1490 L.M.2 | „ | 174 | 0 | 0 |
| B.S. 1490 L.M.4 | „ | 183 | 0 | 0 |
| B.S. 1490 L.M.6 | „ | 183 | 0 | 0 |
| ***Aluminium Bronze** | | | | |
| BSS 1400 AB.1 | ton | 243 | 0 | 0 |
| BSS 1400 AB.2 | „ | 251 | 0 | 0 |

| | | £ | s. | d. |
|---|---|---|---|---|
| ***Brass** | | | | |
| BSS 1400-B3 65/35 | ton | 174 | 0 | 0 |
| BSS 249 | „ | | — | |
| BSS 1400-B6 85/15 | „ | 221 | 0 | 0 |
| ***Gunmetal** | | | | |
| R.C.H. 3/4% | ton | | — | |
| (85/5/5/5) LG2 | „ | 217 | 0 | 0 |
| (86/7/5/2) LG3 | „ | 227 | 0 | 0 |
| (88/10/2/1) | „ | 290 | 0 | 0 |
| (88/10/2/½) | „ | 280 | 0 | 0 |
| ***Manganese Bronze** | | | | |
| BSS 1400 HTB1 | „ | 193 | 0 | 0 |
| BSS 1400 HTB2 | „ | 210 | 0 | 0 |
| BSS 1400 HTB3 | „ | 229 | 0 | 0 |
| **Nickel Silver** | | | | |
| Casting Quality 12% | „ | 248 | 0 | 0 |
| „ „ 16% | „ | 268 | 0 | 0 |
| „ „ 18% | „ | 298 | 0 | 0 |
| ***Phosphor Bronze** | | | | |
| B.S.1400P.B.1.(A.I.D. released) | „ | 306 | 0 | 0 |
| B.S. 1400 L.P.B.1 | „ | 238 | 0 | 0 |

**Average prices for the last week-end.*

| | | £ | s. | d. |
|---|---|---|---|---|
| **Phosphor Copper** | | | | |
| 10% | ton | 250 | 0 | 0 |
| 15% | „ | 253 | 0 | 0 |
| **Phosphor Tin** | | | | |
| 5% | „ | 868 | 0 | 0 |
| **Silicon Bronze** | | | | |
| BSS 1400-SB1 | „ | 280 | 0 | 0 |
| **Solder,** soft, BSS 219 | | | | |
| Grade C Tinmans | „ | 364 | 10 | 0 |
| Grade D Plumbers | „ | 292 | 5 | 0 |
| Grade M | „ | 400 | 15 | 0 |
| **Solder,** Brazing, BSS 1845 | | | | |
| Type 8 (Granulated) | lb. | | — | |
| Type 9 „ | „ | | — | |
| **Zinc Alloys** | | | | |
| BSS 1004 Alloy A | ton | 117 | 6 | 3 |
| BSS 1004 Alloy B | „ | 121 | 6 | 3 |
| Sodium-Zinc | lb. | | 2 | 7 |

## Semi-Fabricated Products

Prices vary according to dimensions and quantities. The following are the basis prices for certain specific products.

| | | £ | s. | d. |
|---|---|---|---|---|
| **Aluminium** | | | | |
| Sheet 10 S.W.G. | lb. | | 2 | 10½ |
| Sheet 18 S.W.G. | „ | | 3 | 0½ |
| Sheet 24 S.W.G. | „ | | 3 | 3½ |
| Strip 10 S.W.G. | „ | | 2 | 10½ |
| Strip 18 S.W.G. | „ | | 2 | 11½ |
| Strip 24 S.W.G. | „ | | 3 | 1 |
| Circles 22 S.W.G. | „ | | 3 | 4½ |
| Circles 18 S.W.G. | „ | | 3 | 3½ |
| Circles 12 S.W.G. | „ | | 3 | 2½ |
| Plate as rolled | „ | | 2 | 10 |
| Sections | „ | | 3 | 4 |
| Wire 10 S.W.G. | „ | | 3 | 1½ |
| Tubes 1 in o.d. 16 S.W.G. | „ | | 4 | 4 |
| **Aluminium Alloys** | | | | |
| BS1470. HS19W. | | | | |
| Sheet 10 S.W.G. | „ | | 3 | 3 |
| Sheet 18 S.W.G. | „ | | 3 | 5½ |
| Sheet 24 S.W.G. | „ | | 4 | 1 |
| Strip 10 S.W.G. | „ | | 3 | 3 |
| Strip 18 S.W.G. | „ | | 3 | 4½ |
| Strip 24 S.W.G. | „ | | 4 | 0½ |
| BS1477. HP30M. | | | | |
| Plate as rolled | „ | | 3 | 1 |
| BS1470. HC15WP. | | | | |
| Sheet 10 S.W.G. | „ | | 4 | 3 |
| Sheet 18 S.W.G. | „ | | 4 | 8½ |
| Sheet 24 S.W.G. | „ | | 5 | 8½ |
| Strip 10 S.W.G. | „ | | 4 | 4 |
| Strip 18 S.W.G. | „ | | 4 | 8½ |
| Strip 24 S.W.G. | „ | | 5 | 4½ |
| BS1477. HPC15WP. | | | | |
| Plate heat treated | „ | | 3 | 10½ |
| BS1475. HG19W. | | | | |
| Wire 10 S.W.G. | „ | | 4 | 2 |
| BS1471. HT19WP. | | | | |
| Tubes 1 in. o.d. 16 S.W.G. | „ | | 5 | 5 |
| BS1476. HE19WP. | | | | |
| Sections | „ | | 3 | 4 |
| Split tube | | | | |
| 19 S.W.G. (¼″) | „ | | 4 | 2 |
| 20 S.W.G. (⅜″) | „ | | 3 | 11 |
| 21 S.W.G. (⅜″) | „ | | 4 | 1 |
| 22 S.W.G. (½″) | „ | | 4 | 11 |
| Welded tube 14 to 20 S.W.G. (sizes ¼″ to 1½″) | „ | 3/10½ to 5/8½ | | |

| | | £ | s. | d. |
|---|---|---|---|---|
| **Brass** | | | | |
| Tubes | lb. | | 1 | 9⅝ |
| Brazed Tubes | „ | | 3 | 2½ |
| Drawn Strip Sections | „ | | 3 | 2 |
| Sheet | ton | 197 | 0 | 0 |
| Strip | „ | 197 | 0 | 0 |
| Extruded Bar | lb. | | 2 | 0½ |
| Condenser Plate (Yellow Metal) | ton | 179 | 0 | 0 |
| Condenser Plate (Naval Brass) | „ | 191 | 0 | 0 |
| Wire | lb. | | 2 | 8¼ |
| **Beryllium Copper** | | | | |
| Strip | „ | 1 | 4 | 11 |
| Rod | „ | 1 | 1 | 6 |
| Wire | „ | 1 | 4 | 9 |
| **Copper** | | | | |
| Tubes | lb. | | 2 | 1⅞ |
| Sheet | ton | 255 | 10 | 0 |
| Strip | „ | 255 | 10 | 0 |
| H.C. Wire | „ | 272 | 15 | 0 |
| **Cupro Nickel** | | | | |
| Tubes 70/30 | lb. | | 3 | 5½ |

| | | £ | s. | d. |
|---|---|---|---|---|
| **Lead** | | | | |
| Pipes (London) | ton | 104 | 0 | 0 |
| Sheet (London) | „ | 101 | 15 | 0 |
| Tellurium Lead | „ | £6 extra | | |
| **Nickel Silver** | | | | |
| Sheet and Strip 10% | lb. | | 3 | 9¾ |
| Wire 10% | „ | | 4 | 2¾ |
| **Phosphor Bronze** | | | | |
| Wire | „ | | 4 | 0⅜ |
| **Titanium** (1,000 lb. lots) | | | | |
| Billet 4½″ to 18″ dia. | lb. | 47/- | | 48/- |
| Rod ½″ to 4″ dia. | „ | 85/- | | 53/- |
| Wire ·036″-232″ dia. | „ | 159/- | | 99/- |
| Strip ·001″ to ·048″ | „ | 350/- | | 68/- |
| Sheet 8′×2′. 20 gauge | „ | 73/- | | |
| Tube, representative average gauge | „ | 198/- | | |
| Extrusions | „ | 90/- | | |
| **Zinc** | | | | |
| Sheet | ton | 122 | 0 | 0 |
| Strip | „ | nom. | | |

# Domestic and Foreign

Merchants' average buying prices delivered, per ton, 14/2/61.

| | £ |
|---|---|
| **Aluminium** | |
| New Cuttings | 139 |
| Old Rolled | 112 |
| Segregated Turnings | 74 |
| **Brass** | |
| Cuttings | 158 |
| Rod Ends | 141 |
| Heavy Yellow | 132 |
| Light | 127 |
| Rolled | 145 |
| Collected Scrap | 131 |
| Turnings | 134 |
| **Copper** | |
| Wire | 203 |
| Firebox, cut up | 200 |
| Heavy | 198 |
| Light | 195 |
| Cuttings | 205 |
| Turnings | 182 |
| Braziery | 177 |

| | £ |
|---|---|
| **Gunmetal** | |
| Gear Wheels | 192 |
| Admiralty | 192 |
| Commercial | 180 |
| Turnings | 175 |
| **Lead** | |
| Scrap | 56 |
| **Nickel** | |
| Cuttings | — |
| Anodes | 555 |
| **Phosphor Bronze** | |
| Scrap | 180 |
| Turnings | 175 |
| **Zinc** | |
| Remelted | 72 |
| Cuttings | 60 |
| Old Zinc | 40 |

# Metal Statistics

Detailed figures of the consumption and output of non-ferrous metals for the month of December, 1960 have been issued by the British Bureau of Non-Ferrous Metal Statistics, as follows in long tons:—

| COPPER | Gross Weight | Copper Content |
|---|---|---|
| Wire | 22,487 | 22,051 |
| Rods, bars and sections | 15,073 | 9,883 |
| Sheet, strip and plate | 13,536 | 10,566 |
| Tubes | 7,000 | 6,411 |
| Castings and miscellaneous | 8,256 | — |
| Sulphate | 2,533 | — |
| | 68,885 | 56,279 |
| Of which: | | |
| Consumption of Virgin Copper | | 43,311 |
| Consumption of Copper and Alloy Scrap (Copper Content) | | 12,968 |

| LEAD | |
|---|---|
| Cables | 8,372 |
| Batteries | 2,731 |
| Battery Oxides | 2,582 |
| Tetra Ethyl Lead | 2,417 |
| Other Oxides and Compounds | 1,933 |
| White Lead | 623 |
| Shot | 460 |
| Sheet and Pipe | 5,391 |
| Foil and Collapsible Tubes | 344 |
| Other Rolled and Extruded | 682 |
| Solder | 1,251 |
| Alloys | 1,726 |
| Miscellaneous Uses | 1,636 |
| Total | 30,148 |

| TIN | |
|---|---|
| Tinplate | 676 |
| Tinning: | |
| Copper Wire | 44 |
| Steel Wire | 8 |
| All other | 74 |
| Solder | 150 |
| Alloys | 471 |
| Foil and Collapsible Tubes, etc. | 42 |
| Tin Compounds, Salts, and Miscellaneous Uses | 123 |
| Total Consumption | 1,588 |

| ZINC | |
|---|---|
| Galvanising | 7,647 |
| Brass | 9,995 |
| Rolled Zinc | 2,067 |
| Zinc Oxide | 2,130 |
| Zinc Die-casting alloy | 4,535 |
| Zinc Dust | 1,198 |
| Miscellaneous Uses | 909 |
| Total, All Trades | 28,481 |
| Of which: | |
| High purity 99·99 per cent | 5,054 |
| Electrolytic and high grade 99·95 per cent | 4,966 |
| Prime Western, G.O.B. and debased | 10,768 |
| Remelted | 458 |
| Scrap Brass and other Cu alloys | 4,288 |
| Scrap Zinc, alloys and residues | 2,657 |

| ANTIMONY | |
|---|---|
| Batteries | 119 |
| Other Antimonial Lead | 54 |
| Bearings | 21 |
| Oxides—for White Pigments | 110 |
| Oxides—other | 80 |
| Miscellaneous Uses | 16 |
| Sulphides | 9 |
| Total Consumption | 409 |
| **Antimony in scrap** | |
| For Antimonial Lead | 442 |
| For Other Uses | 18 |
| Total Consumption | 460 |

| CADMIUM | |
|---|---|
| Plating Anodes | 31·90 |
| Plating Salts | 7·80 |
| Alloys: Cadmium Copper | 5·45 |
| Alloys: Other | 3·65 |
| Batteries: Alkaline | 7·05 |
| Batteries: Dry | 0·35 |
| Solder | 9.10 |
| Colours | 23·70 |
| Miscellaneous Uses | 1·75 |
| Total Consumption | 90·75 |

# Scrap Metal Prices

The figures in brackets give the English equivalents in £1 per ton:—

**France** (new francs per kilo):

| | | |
|---|---|---|
| Electrolytic copper scrap | (£218.0.0) | 2.95 |
| Heavy copper | (£218.0.0) | 2.95 |
| No. 1 copper wire | (£210.12.0) | 2.85 |
| Brass rod ends | (£162.11.0) | 2.20 |
| Zinc castings | (£65.0.0) | 0.88 |
| Lead | (£64.5.0) | 0.87 |
| Aluminium | (£134.9.0) | 1.82 |

**Italy** (lire per kilo):

| | | |
|---|---|---|
| Aluminium soft sheet clippings (new) | (£178.2.0) | 305 |
| Lead, soft, first quality | (£79.8.0) | 136 |
| Lead, battery plates | (£43.16.0) | 75 |
| Copper, first grade | (£207.6.0) | 355 |
| Bronze, commercial gunmetal | (£169.1.0) | 290 |
| Brass, heavy | (£140.3.0) | 240 |
| Brass, light | (£125.11.0) | 215 |
| Brass, bar turnings | (£143.1.0) | 245 |
| Old zinc | (£57.4.0) | 98 |

**Japan** (Yen per metric ton):

| | | |
|---|---|---|
| Electrolytic copper | (£—) | 273,000 |
| Copper wire No. 1 | (£—) | 253,000 |
| Copper wire No. 2 | (£—) | 234,000 |
| Heavy copper | (£—) | 243,000 |
| Light copper | (£—) | 203,000 |
| Brass, new cuttings | (£—) | 185,000 |
| Red brass scrap | (£—) | 212,000 |

**West Germany** (D-marks per 100 kilos):

| | | |
|---|---|---|
| Used copper wire | (£195.1.0) | 225 |
| Heavy copper | (£190.14.0) | 220 |
| Light copper | (£173.8.0) | 200 |
| Heavy brass | (£125.14.0) | 145 |
| Light brass | (£86.14.0) | 105 |
| Soft lead scrap | (£50.5.0) | 58 |
| Zinc scrap | (£47.13.0) | 55 |
| Used aluminium unsorted | (£78.1.0) | 90 |

# Trade Publications

**Mobile Shears.**—Vanesco Ltd., Beddington Lane, West Croydon, Surrey.

This useful leaflet describes the company's scrap shears, type M.G.A., made by H. Schluter K.G.—Germany. The machine is intended, among other uses, for cutting up light materials, armoured cable, etc. The drive is by flange mounted geared motor, a safety shear pin is incorporated in the coupling to prevent overloading, blades are exchangeable and have four cutting edges. If required, the shears can be supplied as table shears. The leaflet also contains details of cutting capacities, dimensions and weights, and is also illustrated.

**Welding Notes.** — The Suffolk Iron Foundry (1920) Ltd., Sifbronze Works, Stowmarket, Suffolk.

The latest issue of *Sif-Tips*, the house organ of this company, contains a number of useful notes, including a short description of the important part which Sifbronze welding played in the manufacture of the new Ariel "Leader" motor cycle. Other notes deal with high speed production brazing, welding magnesium alloy castings, and the use of Sifbronze in the repair of marine equipment with extensive employment of aluminium bronze alloys.

**Die Steels.** — Hadfields Limited, East Hecla Works, Sheffield, 9.

In this new publication the company offers an indication of the factors affecting die steel selection and, at the same time, brief details of those steels made by the company. A number of illustrations are included.

**pH Meters by E.I.L.**—Electronic Instruments Ltd., Richmond, Surrey.

For over fifteen years this company has specialized in the devising, developing and manufacturing of *p*H meters for research, industrial and many other purposes. This new publication, in colour, well describes the complete range of such meters made by the company.

**Shaker Hearth Furnaces.**—Efco Furnaces Ltd., Queens Road, Weybridge, Surrey.

This eight-page brochure contains information relating to the Efco shaker hearth furnaces including statistical data, diagrams and illustrations of various types of such furnaces.

**Valve Development.**—Audley Engineering Company Ltd., Newport, Shropshire.

A four-page leaflet describes and illustrates the latest range of Audco valves with P.T.F.E. taper sleeved plugs. Valves in cast iron, Audcoloy and stainless steel are available for selective use on severely corrosive services.

**Performance of Taps.** — Production Engineering Research Association, Melton Mowbray, Leics.

A research report on the performance of taps has just been issued by Pera (price 7s. 6d.). The first section of the report concerns measurements taken on various makes of tap to ascertain the accuracy of the features specified in B.S.949:1941 (screwing taps), and also differences in the geometric shape and accuracy of features left to the discretion of the tap manufacturers. The second section deals with tap take and flute area tests. Then follow the general conclusions and recommendations. The report covers 24 pages and is accompanied by photographs, diagrams, statistics, etc.

# THE STOCK EXCHANGE

## *Market Remained Busy But Prices Reacted From Best*

| ISSUED CAPITAL * | AMOUNT OF SHARE | NAME OF COMPANY | MIDDLE PRICE 13 FEBRUARY | + RISE—FALL | DIV. FOR LAST FIN. YEAR | DIV. FOR PREV. YEAR | DIV. YIELD | 1960-61 HIGH | 1960-61 LOW | 1959 HIGH | 1959 LOW |
|---|---|---|---|---|---|---|---|---|---|---|---|
| £ | £ | | | | Per cent | Per cent | | | | | |
| 4,435,792 | 1 | Amalgamated Metal Corporation ... | 29/3 | +6d. | 11 | 9 | 7 10 6 | 34/9 | 25/6 | 33/3 | 23/3 |
| 400,000 | 2/- | Anti-Attrition Metal ... ... | 1/- | —3d. | NIL | 4 | NIL | 1/6 | 0/9 | 1/7½ | 1/- |
| 41,303,829 | Stk. (£1) | Associated Electrical Industries ... | 41/- | —3d. | 15 | 15 | 7 6 3 | 67/3 | 39/3 | 67/- | 54/- |
| 3,236,424 | 1 | Birfield ... ... ... ... ... | 52/- | +3d. | 10 | 15‡ | 3 17 0 | 52/- | 29/- | 75/4½ | 46/- |
| 4,795,000 | 1 | Birmid Industries ... ... ... | 75/- | +2/- | 20 | 20D | 5 6 9 | 75/- | 56/- | 75/6 | 46/9 |
| 5,630,344 | Stk. (10/-) | Birmingham Small Arms ... ... | 31/- | +2/3 | 17½QT | 12½ | 3 15 3 | 32/- | 18/4½ | 69/- | 36/- |
| 203,150 | Stk. (£1) | Ditto Cum. A. Pref. 5% ... ... | 14/10½ | | 5 | 5 | 6 12 3 | 17/4½ | 14/10½ | 17/6 | 15/- |
| 350,580 | Stk. (£1) | Ditto Cum. B. Pref. 6% ... ... | 17/4½ | | 6 | 6 | 6 17 3 | 20/- | 17/1½ | 20/1½ | 17/9 |
| 500,000 | 1 | Bolton (Thos.) & Sons ... ... | 43/- | +6d. | 10 | 10 | 4 13 0 | 43/9 | 37/- | 47/- | 27/6 |
| 300,000 | 1 | Ditto Pref. 5% ... ... ... | 14/- | | 5 | 5 | 7 2 9 | 16/- | 13/6 | 16/- | 14/9 |
| 1,500,000 | Stk. (£1) | British Aluminium Co. Pref. 6% ... | 17/- | —6d. | 6 | 6 | 7 1 3 | 21/1½ | 16/9 | 21/6 | 18/9 |
| 18,846,647 | Stk. (£1) | British Insulated Callender's Cables | 56/6 | | 13½ | 13½ | 4 15 6 | 61/- | 47/6 | 61/- | 45/1½ |
| 17,047,166 | 5/- | British Oxygen Co. Ltd., Ord. ... | 27/3 | | 16 | 16 | 2 18 9 | 34/6 | 19/6 | 87/9 | 49/3 |
| 1,200,000 | Stk. (5/-) | Canning (W.) & Co. ... ... ... | 14/3 | —1½d. | 15+8½C | 25+ *2½C‡ | 5 5 3 | 19/6 | 13/3 | 18/1½ | 12/3 |
| 60,484 | 1/- | Carr (Chas.) ... ... ... ... | 1/1½ | | NIL | 12½ | — | 2/3 | 1/- | 2/10½ | 1/3 |
| 555,000 | 1 | Clifford (Chas.) Ltd. ... ... ... | 26/3 | —3d. | 10 | 10 | 7 12 6 | 35/- | 26/- | 30/- | 22/6 |
| 45,000 | 1 | Ditto Cum. Pref. 6% ... ... | 15/3 | | 6 | 6 | 7 17 6 | 16/- | 15/3 | 16/- | 17/- |
| 300,000 | 2/- | Coley Metals ... ... ... ... | 4/- | +3d. | 15 | 15 | 7 10 0 | 5/- | 3/3 | 4/6 | 2/6 |
| 10,185,696 | 1 | Cons. Zinc Corp.† ... ... ... | 70/6 | +6d. | 20 | 15 | 5 13 6 | 80/- | 60/6 | 77/3 | 57/9 |
| 5,399,056 | 1 | Davy-Ashmore ... ... ... ... | 147/6 | +8/6 | 30‡ | 20 | 2 0 9 | 150/3 | 100/6 | 116/- | 43/- |
| 7,695,000 | 5/- | Delta Metal ... ... ... ... | 22/4½ | +2/1½ | 17½ | 31‡ | 3 18 3 | 28/- | 18/7½ | 26/4½ | 11/6 |
| 5,296,550 | Stk. (£1) | Enfield Rolling Mills Ltd. ... ... | 47/- | —9d. | 15 | 15 | 6 7 9 | 56/3 | 45/- | 61/9 | 36/7½ |
| 1,155,000 | 1 | Evered & Co. ... ... ... ... | 44/- | | 10B | 10φ | 3 0 0 | 42/9 | 29/- | 42/6 | 30/- |
| 18,000,000 | Stk. (£1) | General Electric Co. ... ... | 31/6 | | 10 | 10 | 6 7 0 | 51/6 | 29/3 | 50/6 | 30/- |
| 1,500,000 | Stk. (10/-) | General Refractories Ltd. ... ... | 48/9 | | 20 | 20 | 4 2 0 | 51/6 | 40/- | 47/- | 31/4½ |
| 750,000 | 5/- | Glacier Metal Co. Ltd. ... ... | 14/6 | +3d. | 13 | 11½ | 4 9 9 | 15/9 | 11/1½ | 11/3 | 6/7½ |
| 2,500,000 | 5/- | Glynwed Tubes ... ... ... | 24/- | | 25¶ | 20 | 3 10 6 | 27/1½ | 17/7½ | 30/9 | 16/1½ |
| 7,228,065 | 10/- | Goodlass Wall & Lead Industries ... | 37/6 | | 19L | 16 | 3 16 0 | 41/6 | 33/4½ | 53/- | 28/7½ |
| 696,780 | 10/- | Greenwood & Batley ... ... | 25/3xcap | —6d. | 30W | 30 | 5 18 9 | 27/- | 23/9Z | 130/- | 75/- |
| 792,000 | 5/- | Harrison (B'ham) Ord. ... ... | 12/4½ | | *20‡ | *17½ | 4 0 9 | 15/4½ | 11/9 | 26/9 | 14/- |
| 150,000 | 1 | Ditto Cum. Pref. 7% ... ... | 20/- | | 7 | 7 | 7 0 0 | 20/- | 19/3 | 19/6 | 19/4½ |
| 1,075,167 | 5/- | Heenan Group ... ... ... | 12/3 | | 13D | 15 | 4 12 6P | 12/6 | 10/- | 19/6 | 7/4½ |
| 249,932,548 | Stk. (£1) | Imperial Chemical Industries ... | 69/9 | —1/3 | 11½N | 8 | 3 4 6 | 75/3 | 54/- | 62/7½ | 33/1½ |
| 34,736,773 | Stk. (£1) | Ditto Cum. Pref. 5% ... ... | 15/9 | | 5 | 5 | 6 7 0 | 17/9 | 15/3 | 19/1½ | 15/6 |
| 22,184,044 | ** | International Nickel ... ... ... | 112½ | | $1.60 | $1.50 | 2 9 0 | 113½ | 85½ | 201½ | 154½ |
| 300,000 | 1 | Johnson, Matthey & Co. Cum. Pref. 5% | 14/3 | —3d. | 5 | 5 | 7 0 3 | 16/6 | 14/1½ | 17/6 | 14/9 |
| 6,000,000 | 1 | Ditto Ord. ... ... ... ... | 62/6 | | 12 | 12D | 3 16 9 | 66/6 | 45/- | 50/3 | 27/3 |
| 600,000 | 10/- | Keith, Blackman ... ... ... | 20/- | —3d. | 17½ | 17½E | B 15 0 | 32/6 | 17/9 | 32/- | 25/- |
| 320,000 | 4/- | London Aluminium ... ... | 10/4½ | +4½d. | 12 | 10 | 4 12 6 | 12/6 | 7/6 | 10/7½ | 5/3 |
| 765,012 | 1 | McKechnie Bros. Ord. .. ... | 57/- | | 17½F | 15F | 6 2 9 | 71/6 | 57/- | 62/6 | 39/9 |
| 1,530,024 | 1 | Ditto A. Ord. ... ... ... | 53/9 | | 17½F | 15F | 6 10 3 | 69/3 | 55/- | 65/6 | 38/9 |
| 1,108,268 | 5/- | Manganese Bronze & Brass ... ... | 15/- | +3d. | 20⅝ | 20⅝ | 6 19 0 | 18/9 | 13/4½ | 19/- | 13/6 |
| 50,628 | 6/- | Ditto (7½% N.C. Pref.) ... ... | 6/- | | 7½ | 7½ | 7 10 0 | 6/6 | 6/- | 7/9 | 5/9 |
| 21,745,110 | Stk. (£1) | Metal Box ... ... ... ... | 81/6 | +1/- | 12M | 13B | 2 14 0 | 83/- | 55/9 | 80/- | 44/7½ |
| 415,760 | Stk. (2/-) | Metal Traders ... ... ... ... | 7/3 | | 50 | 50 | 13 15 9 | 10/4½ | 7/1½ | 13/6 | 8/4½ |
| 160,000 | 1 | Mint (The) Birmingham ... ... | 36/9 | | 10 | 10 | 5 8 9 | 39/- | 33/6 | 35/- | 22/- |
| 80,000 | 5 | Ditto Pref. 6% ... ... ... | 76/3 | | 6 | 6 | 7 17 6 | 80/- | 75/- | 80/- | 69/- |
| 5,187,938 | Stk. (£1) | Morgan Crucible A. ... ... ... | 57/6 | +2/3 | 13 | 12 | 4 10 6 | 62/3 | 47/6 | 52/6 | 30/- |
| 1,000,000 | Stk. (£1) | Ditto 5½% Cum. 1st Pref. ... | 16/- | | 5½ | 5½ | E 17 6 | 18/6 | 15/9 | 19/3 | 17/3 |
| 3,850,000 | Stk. (£1) | Murex ... ... ... ... ... | 42/- | +1/4½ | 22½ J | 15 | 6 2 6 | 45/- | 35/3 | 76/4½ | 41/- |
| 585,000 | 5/- | Ratcliffs (Great Bridge) Ord. ... | 16/6 | | 10 | 10R | 3 1 6 | 17/- | 14/9 | — | |
| 195,000 | 5/- | Ditto 8% Max. Ord. ... ... | 5/- | | 8 | — | 8 0 0 | 5/3 | 5/- | — | |
| 1,064,880 | 10/- | Sanderson Kayser ... ... ... | 35/- | +9d. | 35‡ | 25 | 5 0 0 | 40/3 | 27/7½ | 56/- | 27/9 |
| 3,400,500 | Stk. (5/-) | Serck ... ... ... ... ... | 16/1½ | | 12½ | 17½GD | 3 17 0 | 25/- | 15/3 | 26/- | 12/- |
| 7,232,069 | Stk. (£1) | Stone-Platt Industries ... ... | 62/9 | —9d. | 15 | 15 | 4 15 9 | 64/3 | 52/3 | 63/6 | 42/6 |
| 2,928,963 | Stk. (£1) | Ditto 5½% Cum. Pref. ... ... | 15/- | —6d. | 5½ | 5½ | 7 6 9 | 18/7½ | 15/- | 18/9 | 15/10½ |
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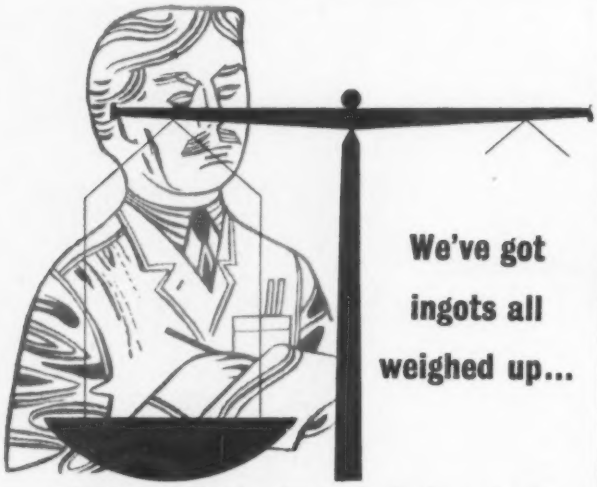

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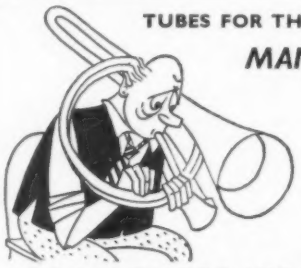

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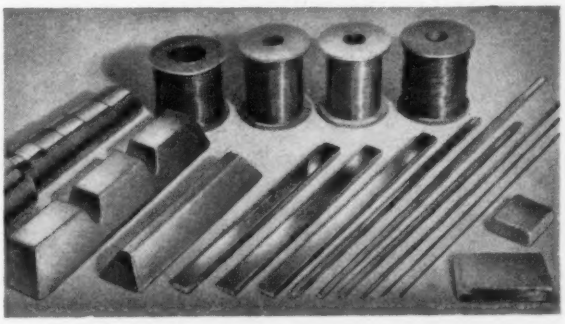

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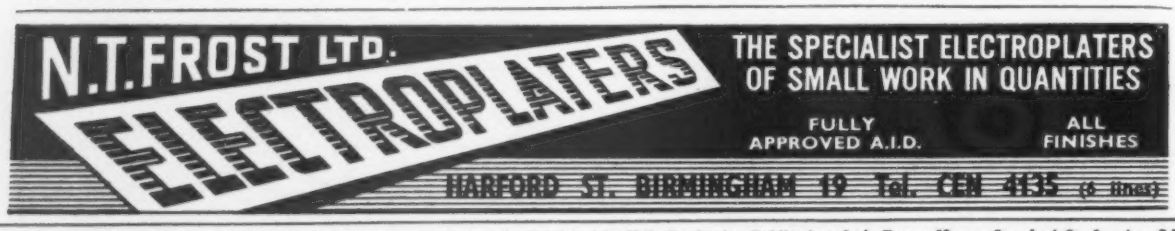
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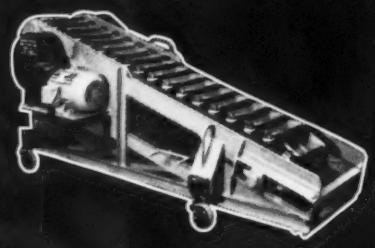

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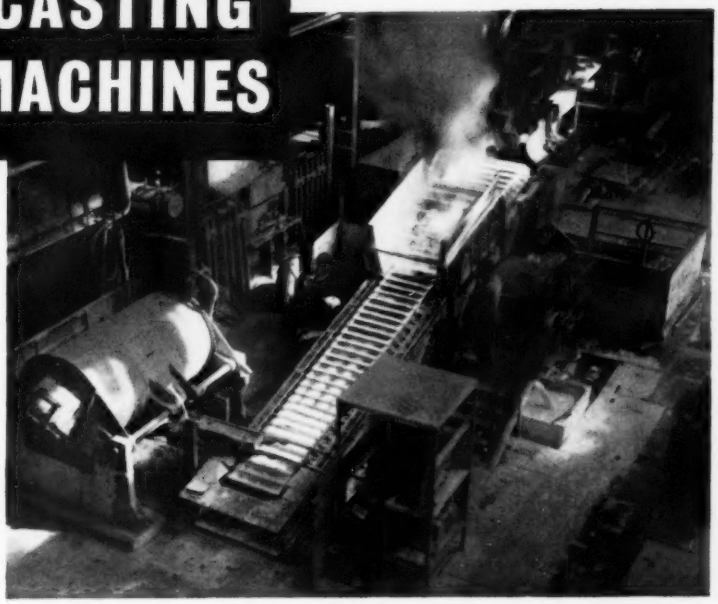

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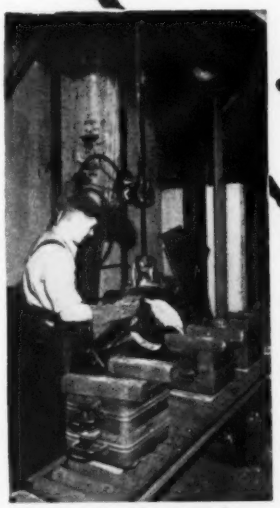

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